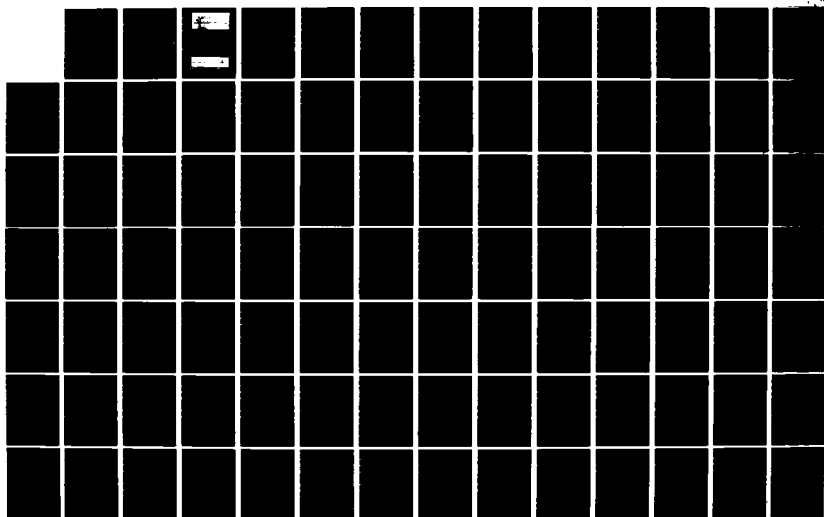AD-A166 641   THE VALUE OF INFORMATION AS AN INTEGRAL PART OF
               AEROSPACE AND DEFENCE R&D PROGRAMMES(U) ADVISORY GROUP
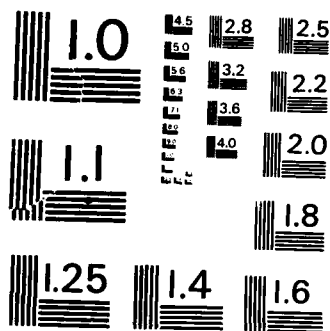   FOR AEROSPACE RESEARCH AND DEVELOPMENT NEUILLY.

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The Value of Information as an Integral Part of Aerospace and Defence R & D Programmes

NORTH ATLANTIC TREATY ORGANIZATION

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AGARD Conference Proceedings No.385

THE VALUE OF INFORMATION AS AN INTEGRAL PART

OF AEROSPACE AND DEFENCE R & D PROGRAMMES

Copies of papers presented at the Technical Information Panel Specialists' Meeting
held in Cheltenham, UK, on 4—5 September 1985

THE MISSION OF AGARD

The mission of AGARD is to bring together the leading personalities of the NATO nations in the fields of science and technology relating to aerospace for the following purposes:

— Exchanging of scientific and technical information;

— Continuously stimulating advances in the aerospace sciences relevant to strengthening the common defence posture;

— Improving the co-operation among member nations in aerospace research and development;

— Providing scientific and technical advice and assistance to the North Atlantic Military Committee in the field of aerospace research and development;

— Rendering scientific and technical assistance, as requested, to other NATO bodies and to member nations in connection with research and development problems in the aerospace field;

— Providing assistance to member nations for the purpose of increasing their scientific and technical potential;

— Recommending effective ways for the member nations to use their research and development capabilities for the common benefit of the NATO community.

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Participation in AGARD activities is by invitation only and is normally limited to citizens of the NATO nations.

SPS

THEME

Scientific and technical information is recognized as a significant factor in the research and development process. A solid base of knowledge is essential to the development of sound programmes for aerospace, defence and other research and development.

Today, the pressures of vast quantities of information, the complexities of new technologies and limited budgets force us to study anew the ways in which we make use of our knowledge base. Policy makers, programme managers and researchers alike must address this issue together to ensure that information is properly managed and used in the R & D process. Aspects considered at the meeting included the need to incorporate information as an integral part of the R & D process, the value of information in reducing the cost and preventing the duplication of research, improvements in the sharing of information resources among the NATO countries, and requirements for the future.

* * *

C'est un fait reconnu que l'information scientifique et technique constitue un facteur important dans le processus de recherche et de développement. Une solide base de connaissances est indispensable à la mise au point de programmes fiables de recherches et de réalisations, entre autres dans le domain aérospatial et celui de la défense.

A l'heure actuelle, les pressions qu'entraîne le volume considérable d'informations, la complexité des technologies nouvelles et les limites budgétaires nous obligent à repenser notre façon d'utiliser nos bases de connaissances. Les décideurs en matière de politique, les responsables de la gestion de programmes, tout comme les chercheurs, doivent tous ensemble s'attaquer à ce problème pour garantir une gestion et une exploitation satisfaisantes de l'information au cours du processus de recherche et de développement. Parmi les points qui furent examinés pendant le réunion figuraient la nécessité d'incorporer l'information au processus du recherche et de développement dont elle doit faire partie intégrante, le rôle de l'information dans la réduction des coûts et la suppression du double emploi en matière de recherche, l'amélioration du partage des ressources d'information entre les pays de l'OTAN et les besoins pour l'avenir.

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The Technical Information Panel wishes to express its thanks to the United Kingdom National Delegates to AGARD for the invitation to hold this symposium in Cheltenham, UK, and for the personnel and facilities made available for this meeting.

CONTENTS

TECHNICAL EVALUATION REPORT

SUMMARY

This report reviews the concept and outcome of the AGARD Technical Information Panel Meeting on 'The Value of Information as an Integral Part of Aerospace and Defence R&D Programmes' held on the 4-5 September 1985 in Cheltenham, UK.

It itemises several topics which were expressed by several speakers or participants during discussions.

1. INTRODUCTION AND BACKGROUND

1.1   Introduction

This report reviews the concept and outcome of the Meeting. It is based on personal observations made during the Meeting and on comments from questionnaires which were completed by participants to the Meeting. Comments were also submitted by Mr W R Blados, Chairman of Session I, and Mr I C Graham of the Royal Signals and Radar Establishment, UK.

1.2   Background

The theme of the Meeting was that the pressures of vast quantities of information, the complexities of new technologies and limited budgets force us to re-think the ways in which we make use of our knowledge base. In particular, the aims of the Meeting were to consider the value of information as an integral part of the R&D process in reducing the cost and preventing the duplication of research, improvements in sharing information resources among the NATO countries, and requirements for the future. It was intended also to develop recommendations as to the resources that should be directed towards providing cost effective information services for future R&D programmes.

2. PROCEEDINGS OF THE MEETING

2.1   Participants

There were ten speakers, four from government departments, three from industry and two from other sources. The tables on the next page show the breakdown of the participants by nationality, whether they were from the R&D community, librarians/information specialists or others. It is significant to note that 87 out of the 133 participants were librarian/ information specialists and only 16 were from the R&D community, so we were preaching to the converted!

2.2   Significant Points of the Presentations or Discussions

A number of points occurred several times during the presentation of the Papers or were the subject of discussion and these are highlighted below.

- The need for information to flow up and down a management structure was emphasised and also management's preference for multiple sources of information to ensure the maximum representation of ideas. It was also said that when an information service is established, such as the proposed NATO Information Service, it should be a totally integrated information system and not a haphazard piecemeal approach. It was emphasised that it should be staffed by specialists in information handling.

- Problems of accessing databases were discussed. The proliferation of databases is causing a constant education problem. The need for a database to be user-friendly was emphasised. If it is not simple to access the database, an intermediary is necessary or the user will not be satisfied with the results and assume that all databases are unsatisfactory. The gateway system of tying together and thus making multiple databases more easily available was mentioned.

- The role of intermediaries was discussed several times and although opposing views on their future were presented, it was overwhelmingly agreed that they would be required for a long time to come. The possibility of intermediaries and technical experts working together to form an information team was postulated as a way of sifting the amount of information presented to the user.

- The difficulty of estimating the absolute value of information was raised by several speakers, one questioner asking if it was possible to attach a value to information relative to the time it was discovered. It was generally agreed that quality and timeliness of information were the most important factors.

NATO MEMBER NATIONS	GOVERNMENT			INDUSTRY			OTHERS		
	Parti-cipants	AGARD TIP	Speakers	Parti-cipants	AGARD TIP	Speakers	Parti-cipants	AGARD TIP	Speakers
Belgium		2	1						
Canada	1	2	1						
France		2		2	1	1			
Fed Rep of Germany		3	1	1					
Greece		1							
Italy							1		
Netherlands	2	2		3			2		
Turkey		1							
United Kingdom	34	1		32	1	2	13		
United States	4	2	1	1		1	2	2	
NATO							2	4	1
TOTAL	41	16	4	39	2	4	20	6	1

NATO MEMBER NATIONS	GOVERNMENT			INDUSTRY			OTHERS		
	Parti-cipants	AGARD TIP	Speakers	Parti-cipants	AGARD TIP	Speakers	Parti-cipants	AGARD TIP	Speakers
Librarian/ Informat on Specialists	27	16	1	23	2	1	10	6	1
Aerospace R&D	6			7		1	2		
Others	8		3	9		2	8		
TOTAL	41	16	4	39	2	4	20	6	1

It was also suggested that R&D productivity might be a measure of technology transfer and hence a way of putting a value on information, and the proposal was made that some controlled experiments should be set up, possibly under the control of TIP, to measure the cost of not having accurate data.

One speaker did quote estimated costs for the value of information, referring to studies carried out for the US Departments of Defense and Energy. The quoted values were very high and surprised many of the participants but it may be significant that they were not seriously challenged by any of the information specialists present. The speaker was asked if these studies had had any effect on budget decisions and he replied that there had been some impact, but not as much as might have been expected from the figures quoted.

- The effect of information technology (IT) on the information scene was discussed. One speaker reminded the audience that it had already been with us for some time and said that it could only be a help not a hindrance, provided that the designers of systems took care to ensure that it did not obscure information. People should not be afraid of it but should use it to improve their services. It was predicted that 'expert systems', taking the place of skilled intermediaries, were some years away and that they would prove very expensive. There would still be a place for Librarians and Information Specialists.

- The use of optical discs for the storage of larger scientific databases was discussed and how to access them. It was stated that optical discs were a good candidate for storing data which is wanted on line but which has only a low flow of requests. The possibility of storing journals was being considered and the Library of Congress was experimenting with storage on optical discs, for recent material as well as archives.

- The protection of proprietary and classified information was an important topic and the meeting discussed the prospects of a secure system for the future. It was emphasised that personnel security was as important as equipment security. It was also stated that the technology already exists for catering for access at different levels of security clearance and that such systems were already in use. Thus it was not necessary to have separate classified and unclassified systems. However, at least one dissenting voice said that such software was not yet fully proven because there were still problems in guaranteeing that the software performed as it was supposed to and that it was tamper-proof.

- The question of automatic translation was raised. It was stated that the EEC uses computer-aided translation plus the human expert. The general feeling was that there was no automatic system which did a really good job except possibly in very limited subject fields such as meteorology. The human influence was still needed.

2.3   Opinions about the Meeting Arrangements

Thirty-nine questionnaires were returned by participants, i.e. 30% of attendees did so. The following comments are based on these and remarks made by Panel Members. The choice of Cheltenham as a meeting place was generally praised although the suggestion was made that all delegates should be under one roof and not scattered through several hotels. The conference room came in for some criticism in that the seating was too close, the ventilation poor and the noise from the air conditioning was distracting. The content of the lectures was well received although people would have preferred to have more specific costs quoted, and several people commented that, although interesting, not all the papers were relevant to the theme. In the overall rating two thirds of the participants gave the meeting a rating of 'very good' to 'good' with most of the remainder 'satisfactory'.

2.4   Bibliography

An addition to this year's Preprints and the final Conference Proceedings is a Bibliography of Selected Readings. Any comments on this would be welcomed. They should be sent to George Hart, Technical Information Panel Executive, AGARD, 7 rue Ancelle, 92200 Neuilly-sur-Seine, France. I should like on behalf of the participants to thank Walter Blados, Van Wente and NASA for producing this Bibliography.

3. CONCLUSIONS

3.1   In reviewing the overall Symposium against the thinking that it would be possible to make recommendations as to the resources that should be provided to establish cost effective information services for the future R&D programmes, I do not feel that it was successful. The fact that the vast majority of the audience were librarians/ information specialists meant that we were lecturing to the converted, but even if the audience had consisted of more R&D managers I do not believe we would have convinced them of the importance and value of information to R&D.

For the majority of the audience, the librarians/information specialists, I am sure the Meeting was a success as shown by the number of questions submitted to the Forum Discussion and, as all these people know only too well, a lot of useful information comes from the dialogues that take place during the intervals and during socialising.

3.2   Suggestions for the Future

TIP sets the theme of the Meeting and I wonder if the titles set were compatible with the theme in regard to steering speakers to be more specific to costs and whether the right specialists were chosen to present the papers. TIP, in setting the theme, should indicate to the speakers those trends which it wishes the lecturers to show and should discuss with speakers whether the titles set will allow them to cover those particular topics.

One Speaker made the point that libraries/information centres do make a useful contribution to the R&D scene and said that if they were not there the service would have to be provided some other way, therefore information managers were in the best position to collect statistics on the amount of use made of their facilities and hence costs. I recommend that TIP discuss the suggestion of a controlled experiment made by Dr Barrett to see whether a quantitative evaluation would be possible.

THE POLICY MAKER LOOKS AT INFORMATION

by

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1. INTRODUCTION AND DEFINITION OF POLICY

The Oxford English Dictionary defines policy as Statecraft, prudent conduct or sagacity. From this it can be seen that the main aim of the policy maker is to map out the best path possible that his organisation should follow in the light of all information received.

Policy making is distinctly different from other activities a Manager may undertake. It is in effect the laying down of rules or guidelines or sometimes just a statement of intent. It is most likely to come out of discussion in different forums, the food for this discussion being information.

The need for policy can arise in two ways. It can be generated previous to an impending action or it can be forced out of an apparently disorganised situation. It should be the aim of good information management to ensure the former happens and that it can be reviewed when necessary.

If one studies Figure 1 entitled 'Information Routes to the Policy Maker', one notices several points.

The policy maker central to the diagram is shown to communicate with his management as a whole in committee, and individual management separately. It must be noted that if members of this committee are of equivalent seniority, then each one is a policy maker in his own right, at this management level. So even though the format describes only one policy maker, the actual results are team efforts coming out of committee meetings and singular efforts from individual discussion.

Discussion by management in committee is generally on the basis of a preset agenda. Prior to a meeting some preparatory information is normally circulated. Preparatory information required for the formulation of policy can be compiled by a secretary or, if the policy maker is lucky enough and feels it necessary, an assistant. The person in this role acts as the policy maker's personal information officer. It is his responsibility using his contacts and local services, libraries etc. and also, in the case of BAe., an M.I.S. (Management Information System) of which more later. The forms and quality of information which the policy maker receives will also be discussed in a later section.

The output of Management meetings may not seem like a policy statement at first sight. It is rare that an actual statement of policy will emerge immediately, this will usually only come about after a series of decisions. The main thing is that the committee is clear on the results of the discussion and agrees with them. It is then up to their skill as Managers to interpret the results (usually laid out in Minutes) for correct application in their field of interest. Their communication skills have to be good enough for group and department leaders to understand, not only their instructions but also the reasoning behind them.

Feedback from the workforce is essential if the system is going to work. This at best should consist of a direct line of communication back to the policy maker using the Personal Information Officer as the interface. This is a line that frequently falls down or breaks down resulting in the feedback having to return by the route which the policy was despatched, and since it is of relatively low priority compared with policy, it can be held up by a series of time-consuming 'In' trays.

To summarize the scheme then, we can interpret it as being similar to a simple computer. The policy maker might represent a well qualified programmer and the office, shop floor the processors. Being a programmer the policy maker speaks a high level language which is open to either interpretation or compilation. The Management Committee and their subordinates can be considered as a large interpreter converting the brief statements of high level language into lengthy machine code. As the computer literate will appreciate, interpreters have the quality of stopping the programme whilst it is being written or grinding to a halt when an unobvious fault is reached. The information officer on the other hand represents a compiler who not only compiles information, but automatically translates it to machine code before the program is run and (with a view of the whole program) has the quality of recognising in-built faults more complex than elementary syntactic errors. Depending on the high level language used interpreters and compilers can work equally as well and should come up with the same result, but as every computer programmer knows, the program might be perfect from the computer's point of view but the results might not be what the policy maker was expecting.
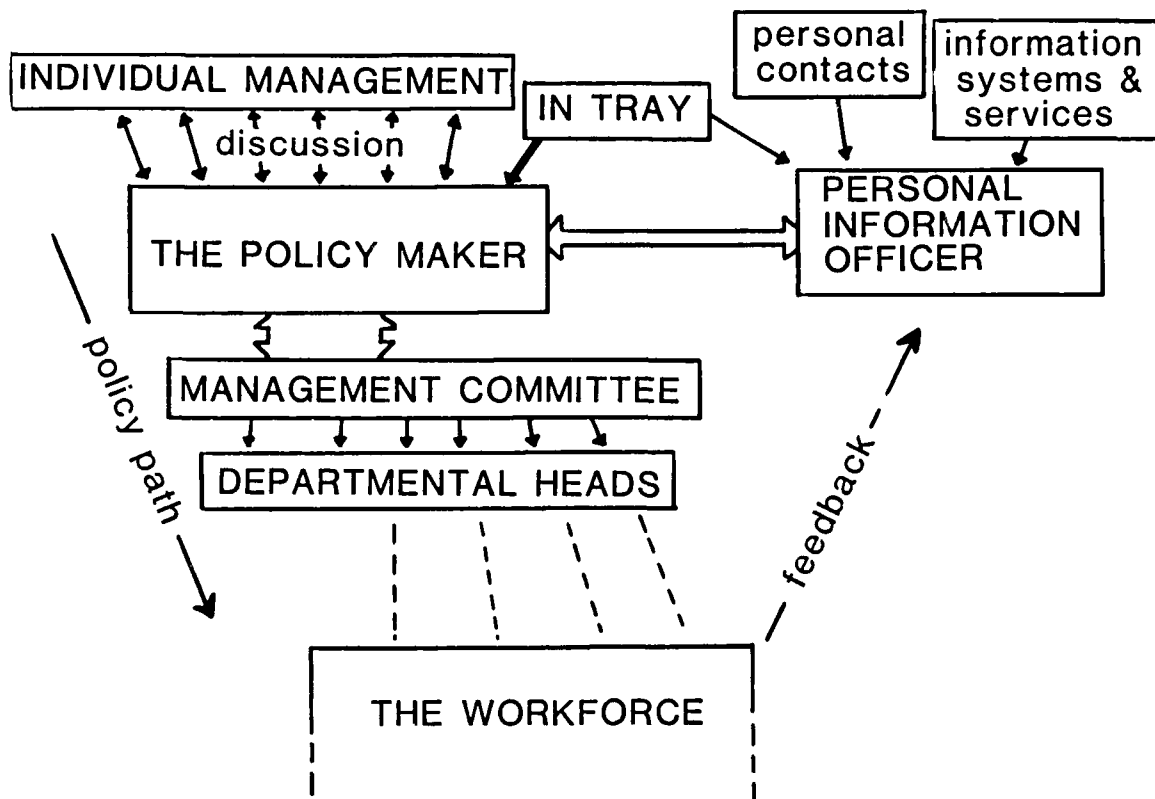
INFORMATION ROUTES TO THE POLICY MAKER

FIGURE 1

Finally in this section, Figures 2 & 3 show the heirarchy of policy-making in the British/European Aerospace scene.   Figures 2 & 3 are separate in order to differentiate between the policy generated within the Company and policy of Government.

Within the Company most levels are capable of policy decisions in their own right and with respect to their own area of interest.   The experience used for the compilation of this paper is taken from Divisional Technical Director level operating in the Divisional Management Committee.   This position can be thought of as standing at the bridge between top level management and the site level design offices and technical departments.

Government policy can influence company policy, but except by legislation, does not control it.   The interaction between Government and company is by the letting of contracts.   However the information flow between Government and Industry at all levels can have a very powerful and direct bearing on the independant policy decisions each side makes.

2.   POLICY MAKING IN ACTION

Firstly let us examine the range of managers who can claim to make policy. Examining Figure 2 again, our experience covers from British Aerospace PLC down to Heads of department.   A policy statement will usually affect the area immediately below the Manager making the statement.   One firm statement will then cause follow-on statements by these subordinates and so the effect is that of an avalanche, although hopefully not that devastating.   However, the return loop, either through management or a Personal Information Officer, will be good for another sequence.

As the policy statements become more numerous they are then not usually recognised as such rather they become decisions made as a result of policy or decisions following an organisation's policy.   However, as long as these decisions and statements continue to map out an abstract best path they must still be recognised as policy.   It could be said that this is belittleing the role of major policy makers higher up in the heirarchy, since it is traditional to think of policy makers as very senior individuals.

The best way of illustrating the scope of policy making is to go through a series of hypothetical policy statements using Figure 2 to show their position in the heirarchy.

POLICY MAKING HEIRARCHY
WITHIN BRITISH AEROSPACE

BRITISH AEROSPACE PLC.

corporate management committee

other divisions   **OPERATING DIVISION**   other divisions

divisional management committee

commercial   **TECHNICAL DIRECTOR**   administration

production   financial

site technical directors meetings

**SITE
TECHNICAL
MANAGEMENT**

**DEPARTMENTAL
HEADS**
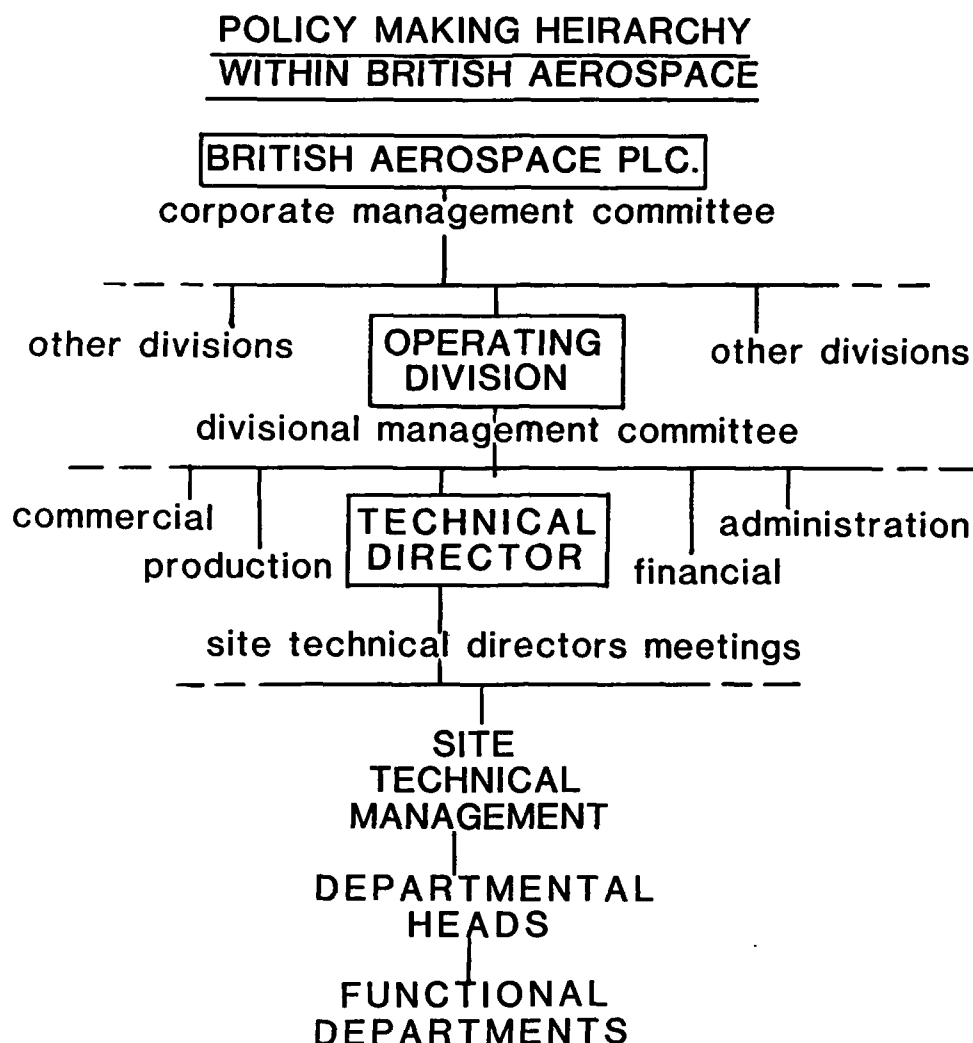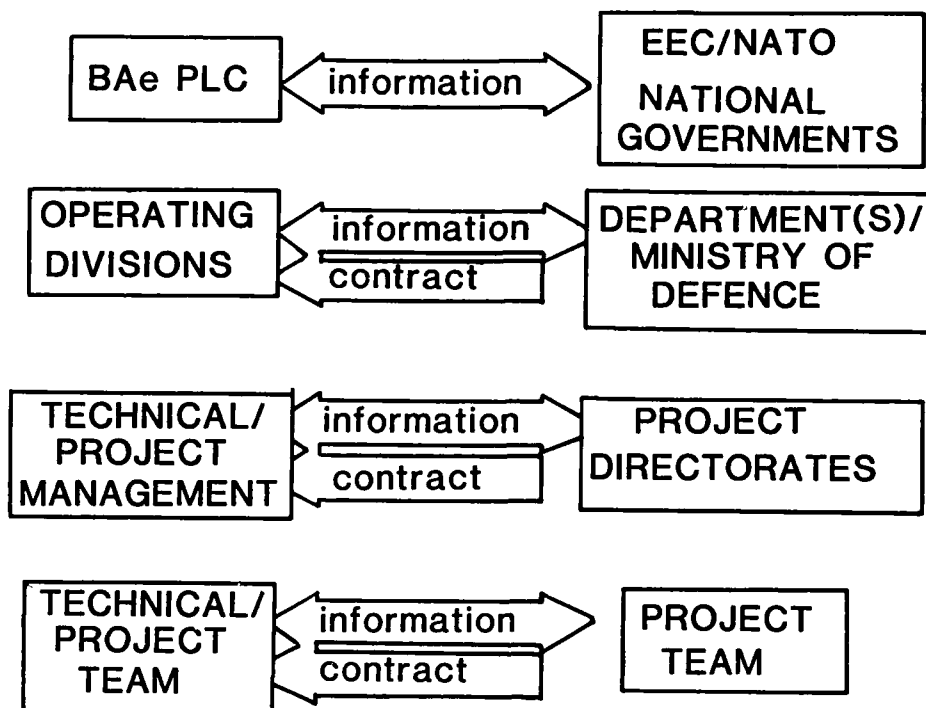
**FUNCTIONAL
DEPARTMENTS**

FIGURE 2

The two illustrations shown in Figs. 4 & 5 form examples of a series of decisions in varying seniority. The diagrams do not by any means show all decisions made.

Figure 4 shows the information path for a typical research project into the use of Aluminium/Lithium Alloy as a structural material. The decisions are at most taken within a Division although the policy makers are required to know of extra mural work going on in this field. Two policies are required - one to outline the research aims (e.g. demonstrator aircraft, structural test samples) and the later one to guide the eventual implementation into a production batch.

The example of Figure 5 is more global and embraces most facets of British Aerospace. It shows the sequence in the birth of a new aircraft project. Initially, project work and market research, work hand in hand, although realistically market research cannot take place until a raw specification (i.e. liable to future modification) is available, but this can also come out of a projected market requirement. Planning and costing cannot begin until policy in the shape of an outline project proposal has been received. Once this is complete a total proposal can be submitted to the Managing Director, who will supply the ultimate policy decision in the light of all other company activities. Once the go-ahead is received, then a detailed project proposal is needed to start the manufacture of the first development aircraft and a subsequent production batch given that launch orders have been received.

POLICY MAKING OUTSIDE BRITISH AEROSPACE

BAe PLC	⟵ information ⟶	EEC/NATO NATIONAL GOVERNMENTS
OPERATING DIVISIONS	⟵ information ⟶ / contract	DEPARTMENT(S)/ MINISTRY OF DEFENCE
TECHNICAL/ PROJECT MANAGEMENT	⟵ information ⟶ / contract	PROJECT DIRECTORATES
TECHNICAL/ PROJECT TEAM	⟵ information ⟶ / contract	PROJECT TEAM

INDUSTRY   GOVERNMENTS

FIGURE 3

3.   INFORMATION QUALITY TO THE POLICY MAKER

If one refers to Figure 1, 'Information Routes to the Policy Maker' three 'official' routes to the manager are labelled.   Namely the immediate management and management committee, the personal information officer and the 'in-tray'.
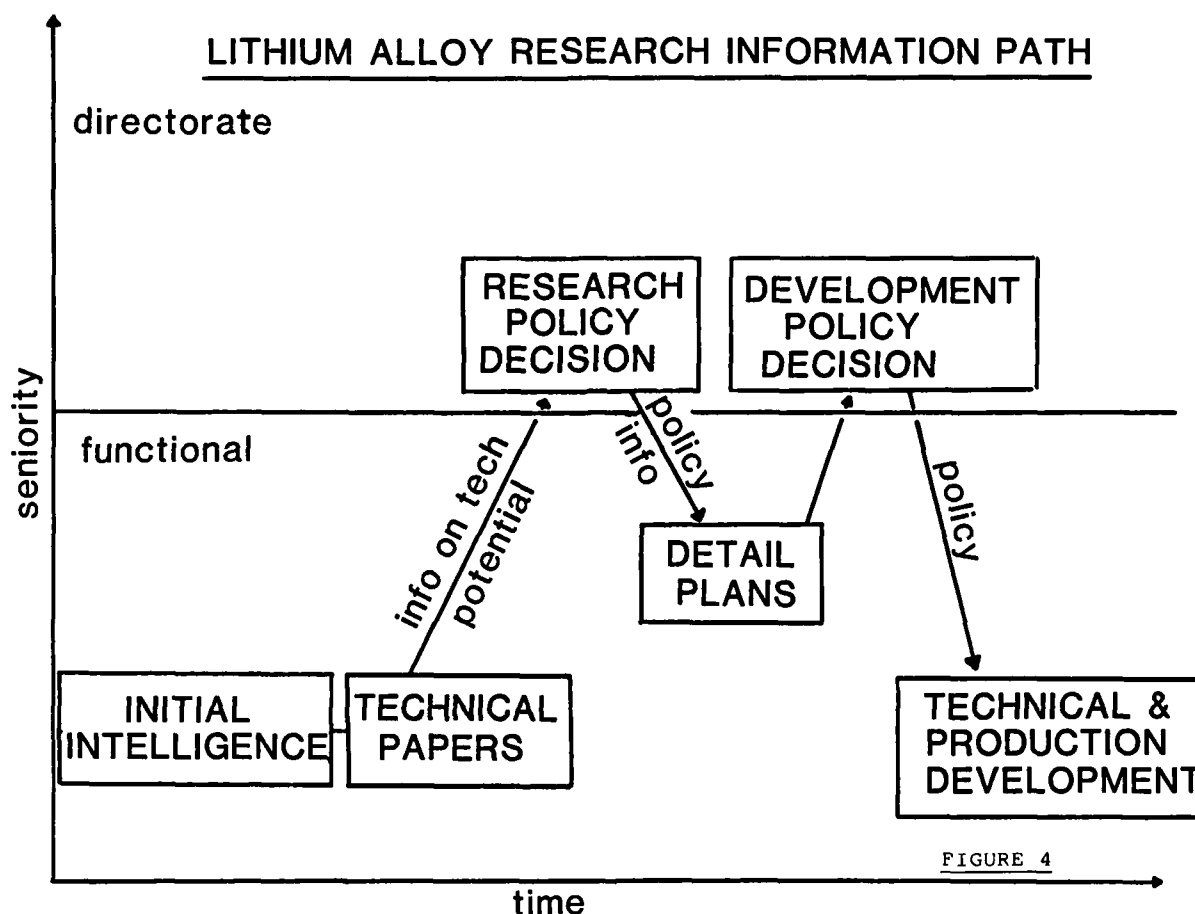
(i)   Management and Management Committee.

The title to this sub-section infers two sources of information.   An information exchange with other members of management (e.g. telephone conversation) can involve two or more members but this does not imply a Management Committee meeting.   Experience has shown that more information can be gathered on a one to one basis and is quick given the availability of managers.   Another attraction of the informal personal route is that an automatic line command, that is to say one immediately recognises who is officially 'boss'.   However, no doubt personality takes over once communication has been set up.

Unfortunately, say in the case of a conversation with management at a remote factory or site, information can easily be presented in a biased manner. A good divisional manager, then, is one who can see through this 'flowering' of information.

Conventionally, committee style presentation of information takes two forms either verbal (memorised) or written (minuted).   The minutes of the meeting should cover in theory as much as, if not all, of what is discussed.   The Chairman then, will be the person who will ultimately 'rubber stamp' policy, hopefully with the full concensus of his forum.   However, it may take several

interations and more individual discussion before clear policy emerges.
The number of iterations then depends on the strength of the committee
member in terms of resolve, discussion and broad-mindedness.   Some-
times a lack of information will cause a delay until it is made avail-
able.

LITHIUM ALLOY RESEARCH INFORMATION PATH

directorate

```
                    ┌──────────────┐   ┌──────────────┐
                    │   RESEARCH   │   │ DEVELOPMENT  │
                    │    POLICY    │   │   POLICY     │
                    │   DECISION   │   │  DECISION    │
                    └──────────────┘   └──────────────┘
```

functional

info on tech / potential   policy info   policy

```
┌──────────────┐  ┌──────────────┐        ┌──────────────┐
│   INITIAL    │  │  TECHNICAL   │        │  TECHNICAL & │
│ INTELLIGENCE │  │   PAPERS     │        │  PRODUCTION  │
└──────────────┘  └──────────────┘        │ DEVELOPMENT  │
                                          └──────────────┘
              ┌──────────────┐
              │   DETAIL     │
              │   PLANS      │
              └──────────────┘
```

seniority

FIGURE 4

time

(ii)   Personal Information Officer.

This person can take the form of a technical/personal assistant, or a
secretary - in fact it could be anyone the manager is able to nominate
for this task, but for the purposes of this text we shall refer to him/
her as the Personal Information Officer.   It is the officer's job to
take in the many different forms of information and sort them out such
that the policy maker need only scan the minimum information to make a
decision.

His sources of information should be varied.   The lack of seniority
afforded to this type of information officer should be used to the full,
so that a line of communication can be set up between him and the office
floor staff.   This gives him, and in effect the policy maker, direct
feedback through the loop of policy decision.

The Personal Information Officer should theoretically have time to sift
through more time-consuming pieces of information e.g. Press releases,
Scientific and Technical papers etc., but without adequate time management
this is not always the case.

His contact with the policy maker must be brief and concise.   Obviously
urgent information would be passed by word of mouth, but if the information
is to be considered for collective policy making, short reports containing
only relevant quotes are necessary.   These reports rarely have a definitive
conclusion but should include opposing views.   The information should first
be classified with some general discussion at the end and should always be
preceded by a brief summary or abstract.

4. SELF IMPROVEMENT FOR THE POLICY MAKER

This section is entitled 'Self-improvement' because generally policy makers are nearer the purse strings for purchasing the hardware for executing their desired tasks. This points directly to electronic computing facilities not only to prepare and crunch numbers but also to communicate with the suppliers and sharers of information.

Senior policy makers, notably in the Aerospace Industry, seem to be the last to adopt new technology willingly. There are exceptions, of course. In our experience it has been engineering middle management that has implemented computer based office and information systems first. The reason probably being that this level is more exposed to practical applications of computing in the technical work which is their bread and butter.

The Senior Manager/policy maker's stance has so far been to approach a computerised system with a singular specific requirement. In our case the first requirement was for labour forecasting on Design Projects. Misconceptions arise when computer services managers claim that they can perform all the tiresome tasks required e.g. preparing graphs, tables and matrices. This is usually perceived as an ability to reproduce exactly what has gone before, human judgments, estimation and rules of thumb taken into account. The best policy for Computer Services Managers to take when introducing senior policy makers to the facilities of a management or office system is to provide an information database first and foremost, and then progress to more intelligent systems. A tolerance will grow of the inadequacies, such as raster display systems, as time goes by.

It is unfortunate that Senior Management must be weaned onto computer systems but the alternatives are unacceptable. If the policy maker does not make use of computer based systems, he risks slowing his response time down compared with that of his competitors. Too much high technology at once and he is likely to be disillusioned very quickly and send the hardware back from whence it came.

The situation improves if one member of a policy making committee demonstrates a computer's worth and takes a lead. The result, hopefully, is that other members will very soon want duplicate systems whether the requirement is there or not.

Every policy maker's needs are going to be different, but what should be common is the interrogation required of the database. As stated earlier the prime early requirement is for a well presented database. In the case of manpower deployment and forecasting a spread sheet type of display is at first sufficient. Other information could include:-

1. Operating reports (with summary index).

2. Management reports (with summary index).

3. Announcements.

4. Appointments.

5. Economic indicators.

6. Organisation charts.

7. Prestel.

8. Personal office functions.

Operating and Management reports can be stored in their entirety with an index of titles with abstracts.

This, along with the other inclusions, throws up a more important question. Is the Senior policy maker going to be willing to use a video terminal? The eventual answer must be yes, but not immediately. The reason is probably lack of time and psychological, and the latter is something an engineer is not qualified to comment on. But the best remedy remains one of gradual introduction. Until the policy maker is heard saying, "I can't imagine how we ever coped without it", computer services cannot truly claim that they have succeeded.

For the policy maker himself, a constant awareness of a new facility is initially essential. This is where the Personal Information Officer can make another appearance, but unfortunately this could lead to his eventual redundancy. With relatively little computer literacy the Personal Information Officer can keep his boss abreast of new formats for information, and feed back the policy maker's ideas into the database. Certainly with comple.. project management systems like ARTEMIS the system user is operating a very high level language and unless the policy maker takes the time for an intensive training course, he is never likely to use such a system on his own to the full.

Obviously information systems for senior policy makers are likely to be, and should be shared, usually between their rank of management, and sometimes with lower and upper ranks. With the facility of restricted distribution on modern office systems, policy makers of a certain rank can keep sensitive information to themselves until policy statements are ready for issue.

The computer services manager should offer something like the following information service:-

1. A day-to-day or week-to-week service of news
    on new facilities, company news and press
    cuttings.

2. The whereabouts of key personnel derived from
    their own electronic mail boxes.

3. Major progress report deadlines

... and many more.

The ideal hardware for the policy maker's office is a micro-computer with the facility to act as a terminal to the office and information system network.   Within BAe most senior managers have micro's situated in a secretary's office where the major function is word processing.   However, this can usually support a compatible terminal in the Manager's office, if he feels it necessary.

The advantages of the self-contained micro in the office is that processing of say, a new spreadsheet of labour information, can be done off line.   The policy maker's requirement will probably change from one period to the next, for example, if the training manager flags up a problem that apprentices are leaving the Company quicker than they are being recruited, the policy maker will need a breakdown of the deployment of all trainees over a period of time from the labour spreadsheets in order that he might review training policy in his area.   It is this reaction to problems and requests as they arise that makes the policy maker's needs individual.

The period-by-period problem-answer situation exists at present.   Project management software such as PROPLAN and ARTEMIS go some way to answering database interrogation quickly, but the senior policy maker is still left somewhat out in the cold.   The answers are limited and expensive.   British Aerospace has made some attempt to face this in the shape of the M.I.S. (Management Information System) aimed at Corporate Board level management.   At present it involves a small group of software engineers basing the service on a remote mainframe computer.   Several management representatives of the senior policy making type have been chosen for the initial trials. All the facilities in the first list in this section are included with more projected for the future.   The whole system is still under evaluation.

DIVISIONAL
MAINFRAME
COMPUTERS

OFFICE
SYSTEMS

DIVISIONAL
M.I.S.

PROFESSIONAL
FUNCTIONS

PROJECT
MANAGEMENT

CORPORATE DATABASE

MANAGEMENT
INFORMATION SYSTEM
(M.I.S.) -FUNCTIONAL

- M.I.S. CONTROLLER
- BASED ON CORPORATE
  MAINFRAME COMPUTER

CORPORATE DIRECTORS
PERSONAL COMPUTING

TELEX AND
INTERNATIONAL MAIL

DIRECT LINKS TO OTHER
CO.s e.g. AIRBUS

SECRETARIES WORD
PROCESSING & FILING

MANAGEMENT
INFORMATION SYSTEM
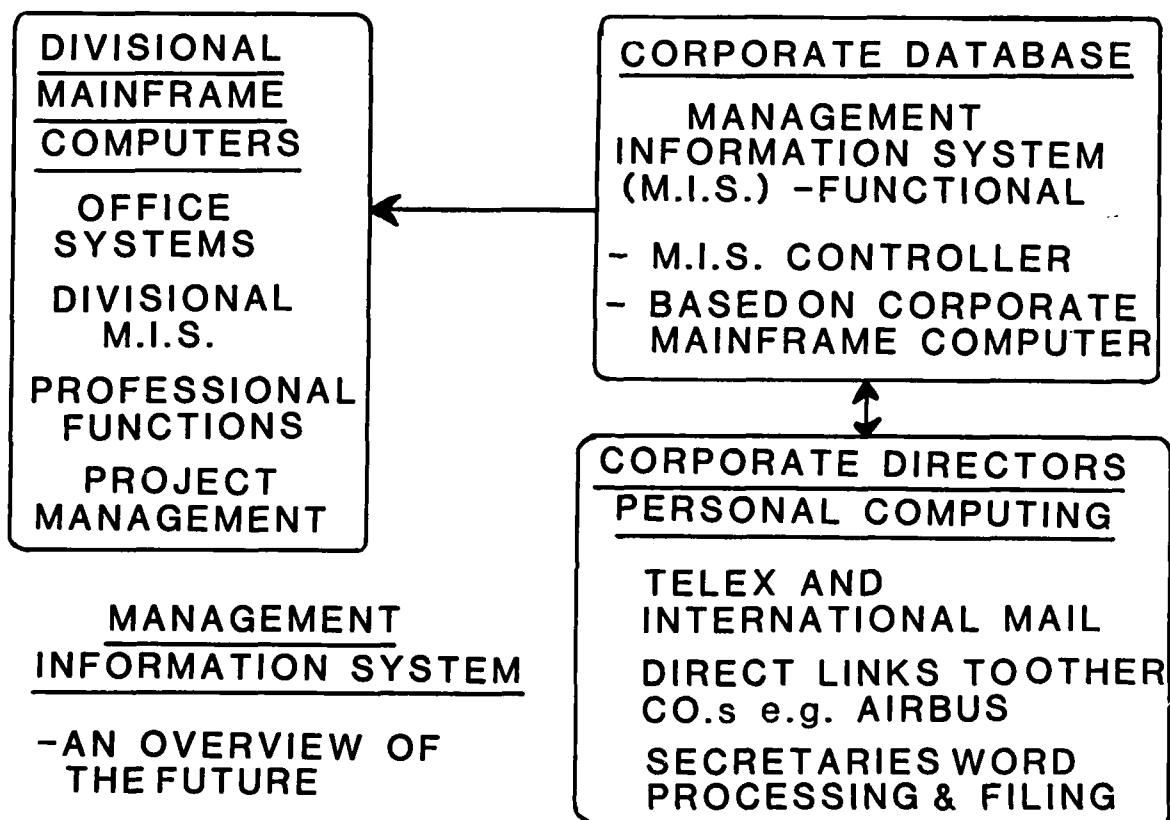
-AN OVERVIEW OF
THE FUTURE

FIGURE 6

The immediate way in which the system is to be enhanced is that according to Figure 6.   Other enhancements will include alternatives to keyboard selection (e.g. mouse, touch screen etc.) and the ability to add 'personal notes' to documents.

In the longer term it is possible to envisage a series of connected MIS databases located on appropriate computers around the Company which would give specific user groups their own views of information.   This would enable the exchange of information between the various functions, locations and management levels.

However, the distinction remains that the system is being developed around the most senior management available and thus will meet their needs first, only allowing the run-of-the-mill office system a small window.

Software which would demonstrate a certain level of intelligence is some way off. This is mainly due to the feedback needed to form a top level software requirement statement.

To summarize, it is clear that there is a need for policy makers to join in the proliferation of office and corporate information systems.   This does not mean that senior policy makers will simply jump on the bandwagon, there is a justification for them to develop continually the information systems they need along ever changing lines - lines that react constantly to their own and the outside world.   If this weren't the case then management's task could be condensed into a computer program and ever increasing profit should emerge as long as the program was running.

5.   THE POLICY MAKER AND EXTERNAL INFORMATION

Figures 1 and 4 show essentially how information is processed within BAe. For the benefit of Managers and policy makers it has been processed and condensed probably several times and it is to this end that most of the automation schemes have been proposed. Much of the information involved is inevitably internal information necessary to enable the company to be run efficiently.   What does he want from outside?

It is unlikely that information obtained directly from outside sources will match a senior manager's requirements precisely unless of course there is a very particular interest.   An exception to this is news - time dependant information often of questionable validity.   News triggers action to establish the credible truth.   Press cuttings are reproduced in every site in BAe for senior managers.   In tomorrow's world a M.I.S. should enable today's news to be available for all from one input source.   The news cuttings can be included so that all news on one subject from over a period of time can be made available to the manager on demand.

Analysis of external information is the basis of many inputs the manager needs. Market researchers provide information based on the trends in the market which primarily comes from external information.   The analysis of technical intelligence provides the input to Future Project thinking - where are we going to adopt new technology, where are we going to retain our present standards.   The source data for analysis wants to be accessible in as complete and organised a form as possible.   The senior manager will not be undertaking the analysis himself, but it is vital that he knows the source and reliability of data being used for analysis.   Within the concept of an M.I.S. it would be valuable if the manager can access and sample directly some of the source data being used by his analysts.

Senior managers don't go to Libraries and they don't read technical reports as a matter of habit, they do read Aviation Week.   Why?   They are looking for trends and triggers - to ask questions of their staff.   They cannot afford to be expert, but they can't afford to be ignorant.   The more that information services with the help of automation in the future can meet this latter need of being kept concisely informed the more successful both will be.

Finally a word on symposia.   Senior managers should get out - say once a year - to a gathering such as an AGARD symposium, away from their normal routine.   It is surprising what new perspectives and new ideas get generated.

A PROGRAMME MANAGER'S NEEDS FOR INFORMATION

BY

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SUMMARY

The underlying basis for the "Information Need" of the Programme Manager within the NATO Integrated Communications System Agency (NICSMA) is examined in some detail, in terms of the role of that Agency as exemplified by its current Charter. The various specific needs of the Programme Planner working within this framework are then identified and critically reviewed. Finally, the paper notes the expanding role of the remodelled Agency (NACISA) to include the development of both communications and information systems for NATO; in this context, the urgent need to re-examine the basic information requirements of the Agency is encouraged and proposals sought.

Whilst the views expressed in the paper are solely those of the author and do not necessarily reflect those of the Agency, it is sincerely hoped that this contribution to the work of the Panel will offer an opportunity to solicit advice and ideas from the attending information experts in order to respond to the significant challenge presented by the formaion of the new NATO Communications and Information System Agency (NACISA).

1. INTRODUCTION

The agenda for this meeting of the AGARD Technical Information Panel (TIP) calls for this particular contribution to address the information needs of the "Programme Manager"; moreover, the input is required to slot neatly between contiguous contributions relating respectively to similar needs of "The Policy Maker" and "The Project Leader".

To those already familiar with the somewhat convoluted workings of NATO and its constituent agencies, it will be redundant to point out that no such convenient compartmentation of functuality is found to exist within the organisation. Firstly, there is the key question of agreed "military requirement" versus "affordability"; as the popular author (and engineer) of the fifties, Neville Shute, once postulated: "What is an engineer? - a person who can do, for two shillings and sixpence, what any damn fool can do for five shillings". To further frustrate the orderly process of "Policy" to "Programme" to "Project", there exists in NATO, perhaps more than any other international organisation, yet more complexities, beyond the solely financial, that cloud the issue. The customary objective of providing maximum effectiveness at minimum cost established for an agency addressing high technology systems planning and procurement is immediately de-focussed through competing ambitions of the component Member States. Quite legitimately, and reasonably, each nation separately seeks outcomes that secure, for example, beneficial technological transfer, an acceptable share of production and, with increasing emphasis, measures that stave off the social and political unacceptability of unemployment.

Against this background, if follows that the tidy compartmentation of the panel organiser is immediately frustrated, at least, in respect of this author and his specific mandate. What can be offered in the following paragraphs is a personal view of that individual's perceived needs for Technical Information in performing his duties as a programme planning manager for major NATO communications systems within the NATO Integrated Communications Systems Agency (NICSMA). I will, therefore, within the scope of this brief paper attempt to set out the more important needs, and shortfalls, of information requirement and sources that exist for the NATO Programme Manager, particularly from the point of view of the programme planner. Specifically, the paper addresses firstly the functional role and organisation of the Agency as it is currently established. In this context, the technical support needs of the NICSMA programme planning function is identified and the available sources satisfying that need noted. The principal focus of the paper is then reached, in which the question of what really are the future needs of the Agency is tackled. This central issue is explored in the context of fundamental changes in NATO policy, the expanding role of the Agency and the increasing reliance which is being placed upon the employment of national equipments, services and even systems to meet agreed NATO military and political objectives.

Recognising that, at this time, these considerations apply for a NATO agency still essentially at the embryonic stage, the focus of the paper is necessarily intended to launch discussion and comment, hopefully leading to the evolution of constructive ideas and action to assist in the vital area of technical information support for this new endeavour. Despite the author's inability to fit neatly into the set sequence of the organisers, it is hoped that this offering can contribute to the value of the

2. ROLE, ORGANISATION AND INFORMATION NEED OF THE AGENCY

2.1 The Agency Role

In the early 1970s, NATO recognised the advantage of establishing a central Agency for the planning and implementation of a NATO Integrated Communications System (NICS) and accordingly established a NICS Management Agency (NICSMA), the responsibilities of which were set out in its charter of 26th March 1971 in document C-M(71)19. The principal responsibilities of the Agency were then seen to be:

(a) Carrying out the detailed planning necessary to fulfill the broad function of the Organisation;

(b) Initiating the programming of projects in order to implement approved plans for the NICS;

(c) Implementing approved plans to the point where a completed element of the system becomes operational;

(d) Developing an overall concept for the operational direction, maintenance and logistic support of the system - including the proposals for financing and for providing the necessary operation and maintenance support;

(e) Developing system standards and procedures for the NICS;

(f) Exercising, as directed by the Policy Committee, management control and operational direction of the system;

(g) Carrying out such additional tasks as may be decided by the Policy Committee;

(h) Submitting an annual report to the Policy Committee on the activities of the Agency.

2.2 The Agency Organisation

In response to these defined responsibilities, the NATO Integrated Communications System Management Agency (NICSMA) was established in Brussels, in 1972, comprising both military and civilian personnel. Since that date, the Agency has operated under a number of working structures but the framework of "planning", "implementation" and "support" has been consistently maintained.

The essentials of the current organisation's framework are set out in Figure 1, which also reflects the Agency's emerging role to include Information Systems activities, to which I will refer later.

The principle of operation for the Agency is that Projects, already defined to a certain degree in terms of operational requirement, enter the Agency's sphere of responsibility within the System Planning and Engineering Division; here "system-level" planning is initiated leading to a subsequent detailed planning at the "System Definition" phase. Once a project is adequately defined in terms of technical definition, funding and programmatic detail, it is transferred to the appropriate specialist Implementation Division for source selection, contract award and procurement. On completion of the acquisition phase, the Agency's responsibility lies in the direction of ensuring successful initial in-service operation in readiness for hand-over to the NICS Cengral Operating Authority (NICS-COA). The entire "process" is co-ordinated and directed by the Agency's Directorate and supported by the specialist support groups shown in Figure 1.

2.3 The Scope of the Agency's Information Needs

The Agency's needs for technical information derive directly from this "process" of projects through their "life-cycle" within the Agency, as described above. In the context of the title of this paper, these can be addressed as the Programme Planning Managers' needs and the Programme Implementation Managers' needs, where the term "Programme" can be taken to represent either a very extended and substantial "Project" or an accumulation of similar or highly inter-related "Projects". Moreover, since the following paper in this meeting will address the needs of Project leaders, which is essentially similar to those of the Agency's Programme Implementation Manager as defined above, I will primarily here examine the needs of Programme Planning Managers, with only limited reference to Implementation management needs.

In view of the complexities of "doing business" in, and with, NATO, as set out in the introduction of this paper, the needs of the Programme Planning Manager are exceptionally diverse: the term "technical" is necessarily broadened significantly to include internal - NATO policy - and external - legal/procedural - regulatory information governing the international military and political telecommunications addressed by the Agency. To assist the understanding of the information need of the Programme Manager, in this context, it may be helpful at this stage to list the general technical areas found to comprise the overall communication system to be planned:

- terrestrial radio transmission systems (tropospheric scatter and microwave line-of-sight);

- cable transmission systems (conventional metal and fibre optic);

- voice and data switched-networks;

- maritime communications systems;

- encryption devices and systems;

- communications control systems.

The above represents only the principal individual technical areas of interest. Much effort is, of course, expended on more generalised overall system-level planning and architectural development. However, the list itself already defines certain of the specific information needs discussed below.

3. THE INFORMATION NEEDS WITHIN THE AGENCY

Against the foregoing definition of the function, scope and area of technical information need, the specific information requirement for the Programme Planning Manager within the Agency can be established. For convenience of review, these may be grouped under a number of distinct headings:

(a) NATO Documentation (Classified and Unclassified);

(b) National Defence Documentation (Classified and Unclassified);

(c) International Agreements and Recommendations;

(d) Open Technical Literature;

(e) "Internal" Documentation.

In order more closely to define the specifics of the information need, I will next examine each one of these basic categories in some detail.

3.1 NATO Documentation

This category essentially falls into two distinct sub-divisions:

(a) General Policy Guidance, Recommendation, Regulations and Procedures;

(b) Guidance related to the specific project in hand.

As one would expect, the first of these groupings - General Policy - sets out the "rules of engagement" within which "doing business" in NATO are collectively defined. Whilst it is understandable, and even essential, that basic understandings are established and agreed, what is surprising to most is the very vast extent of this body of documentation. Rather than provide exhaustive, and exhausting, listings of this body of essential guidance in totality, I have attempted to indicate its magnitude and scope through illustrations of the NATO Military and Civil Structure in Figures 2, 3 and 4.

Reference to Figure 2 indicates the overall structure of the Allience, depicting the principal components of the Civil and Military Structure. In Figures 3 and 4 the Civil and Military Structures are expanded to show their constituent parts numbering each some thirty or so individual working elements. When it is further recognised that each individual Committee, Group or Agency shown invariably spawns numerous sub-elements, also producing specific and relevant guidance documentation, one begins to perceive the magnitude of the information collection, collation and control problem that pertains to working in the NATO environment. The problem is further exacerbated due to the dual nature of these structures and bifurcations within each; the guidance information itself is frequently inconsistent or incomplete because of these overlapping responsibilities and omissions. On the more positive side, the NATO Headquarters documentation is clearly codified and accessible through conventional NATO Registries - the only problem is the ubiquitous problem of information retrieval, i.e. knowing definitively which Committee or Group dealt with which piece of guidance and when!

The second of the above two groupings - programme specific guidance - generally does not usually present the same magnitude of difficulty in respect of information retrieval. Since the information is, by definition, specific to the particular Programme, the individual Programme Manager should have established, within his own Programme, a clear record of documentation relating to the Programme itself. The problem, therefore, essentially devolves into one of basic Programme Management. The exception to this somewhat oversimplified statement, however, relates directly to the principal interest of this group, namely, NATO-generated technical information that may, or may not, be relevant to the Programme in hand. The major source of these data comprise:

- SHAPE Technical Centre (STC) documentation;

- Tri-service Group Communications Electronics Equipment (TSGCEE) Stanags;

- AGARD Documentation.

Here again, the difficulties are not so much related to obtaining documentation listings but to relating the potential content of the documentation to the individual Programme.

In summary, aside from some measure of overlap and omission, the basic NATO documentation itself is largely available and responsive to a Programme Planning Manager's needs. The essential problem is one of correlation and retrieval.

3.2 National Defence Documentation

This category of documentation presents perhaps the most difficult of all. Not only does the problem of retrieval, mentioned above, become even more apparent, but here the lack of document titles, listings or even knowledge of their existence becomes a major obstacle. The situation worsens exponentially as the security classification and technological sensitivity increases. Despite the fundamental agreement of NATO Member States within the North Atlantic Treaty to encourage collaboration and mutual aid (notably Articles 2 and 3), for quite understandable reasons of National Security and Commercial sensitivity, essential technical defence information is often denied to NATO as a whole; the related operational capability is therefore essentially excluded from many NATO Programmes. Beyond the greater understanding of the commonality of NATO and national aims and objectives, little seems possible to improve information transfer in this area.

3.3 International Agreements and Recommendations

Despite the strictly military characteristics of the telecommunications systems planned by the Agency, the intense development of civilian technical standards cannot be ignored. It follows, therefore, that increasingly the agreements and recommendations relating to communications standards, interfaces and inter-connection are central to our system development. Most important amongst these are the following:

- CCIR;

- CCITT;

- CEPT;

-ITU Radio Regulation;

- EEC Regulations;

- IEEE Guidelines.

Access to these documents does not generally represent a serious problem other than the customary ones of funding and assigned staffing levels; and indexing is usually clear and understandable to the specialist user. Once again, however, agreements and recommendations are frequently overlapping and even contradictory. Here serious judgements have to be made, often between European and North Americal Standards with significant operational - in terms of interopability - and financial consequences attendant to that decision.

On balance, the technical guidance derived from this class of source material is valuable and relevant, in short, it is better to have it than not have it.

3.4 Open Literature

Here the major problems of "information management" really start to emerge. Firstly, there is the problem of magnitude - many analyses have been performed showing the ever increasing quantity of technical literature. For the telecommunications engineer the problem is most probably greater than in any other single discipline. When one considers the entire range of relevant activity from basic research, through applied development to industrial and governmental activities, the totality of the problem of information control becomes daunting to say the least.

Fortunately for the Programme Manager, having to acquire and apply this vast corporate knowledge, a number of highly effective and highly developed information systems have become available. I do not intend to list these here or to review their merits and demerits; sufficient to say they exist and are available., The problem, to which I will refer later, is the customary one of affordability and the still harder question of how to integrate this class of information system into those directed at the other categories of information sorce referred to previously.

For the meantime, in most parts of NATO we do still have to rely on direct access to the printed page - periodicals, magazines and books. A few of the more valuable sources within this category include:

- Professional journals of National Institutions (e.g. IEE, IEEE);

- Special interest periodicals (e.g. Communication Week, Aviation Week);

- Trade Journals;

- Company and Corporate Publications;

- University Publications;

- International Organisation Publications.

Regular subscription to these publications are perhaps at this time the most used source of obtaining technical information and currency related to Programme development.

3.5 Internal Documentation

Finally, a word about a commonly overlooked aspect of the total information system for the NATO Programme Planner, namely, "Programmatic" information concerning the programme being managed and to those closely related to it. In other words, the individual programme's data base and especially the "Configuration Control" aspects. Examination of almost any NATO project will reveal substantial omissions in Programme documentation and documentation-control. There are many reasons for this shortfall: squeezed budgets, insufficient personnel, rotation of staff, lack of appreciation, lack of ADP support, etc., etc.. Generally, in my experience, it is, at least at the individual level, a case of the "spirit being willing butthe flesh weak", i.e. resource limitations. As I see it, the solution to this major problem, should not in itself be a singular objective. Where, I believe, very large economies of scale can be found, is in the solution of the total "information problem" along the lines reviewed in this section of my paper. If we treat the totality of the Programme Manager's information need as a single contiguous entity and establish a single information system for NATO Programme Planning, Control and Management, not only will the full range of information need be effectively fulfilled but also very substantial cost-saving - vis à vis a host of individual unrelated systems - could be accomplished.

Such a system, I would suggest, would not only solve the information needs of Programme Managers but also those of the associated "Policy Makers" and "Project Leaders" alike.

4. SUMMING UP

In this short review, I have attempted to emphasise the basis for the complex information needs of a Programme Manager within a NATO Agency, with special emphasis on the crucial planning phase.

In this context, the categories of information needs have been identified and potential sources noted. The difficulties and restriction of each source have been discussed. A plea has been made in the paper to adopt a "total information need" rather than a "piecemeal" approach, in order to promote efficiency and lower cost.

At this point in time, the Agency to which my review has been keyed - NICSMA - is at a critical stage in its evolution. Just as in the early 1970s the need was felt for an integrated approach to a telecommunications system for NATO, recent years have seen a growing awareness of a similar need for a coherent approach to this overall NATO C3 system and to "Information Systems" in particular. Accordingly, detailed planning is already in hand for the establishment of a NATO Communications and Information Systems Agency (NACISA) to replace and expand the NICSMA function. To some degree, implementation of this change has essentially already commenced and formal agreements in terms of a revised charter can be expected before long.

In parallel with the changing role, changes in the fundamental approach to procurement and the satisfaction of military and political needs are increasingly in evidence. Traditionally, procurement has been through international competitive bidding of systems and equipments uniquely specified to meet an agreed NATO requirement. Today the emphasis is moving towards an approach that commences with a fundamental study of the scope of the requirement and of potential solution sets. Of equal significance is an emerging trend to examine seriously solutions based, not upon NATO procurement but rather upon the employment of National Defence Systems to meet the NATO need, with direct consequence of a reduced emphasis on Programme implementation vis à vis planning, especially at the system level.

I would suggest, therefore, that, just as the "information need" of the present Agency is squarely based upon its Charter and its traditional way of "doing business", the new Agency will necessarily have to define its requirement for Programme Management information strictly in terms of its emerging role and of the new systems that NATO seeks to employ.

This revised basis will, I submit, radically change NATO's information requirement in this area and place an ever increased strain on NATO and National co-operation regarding information flow and the notorious "two-way street".

It is against this background, and with this perspective, that I present my paper to the Panel as a very preliminary step in defining the information need of the NACISA Programme planner, establishing proposals for the machinery to that need, and made this first tentative step at instigating the vital information exchange to which I referred earlier, in what for NATO is a key area of interest. With that remark, I will clsoe my paper and hopefully launch a vigorous discussion period on a subject that is of deep interest to us all.

FIGURE 1

OUTLINE OF NEW NICSMA ORGANIZATION

DIRECTORATE

PRINCIPAL TECHNICAL ADVISER
LEGAL ADVISER
INTERNAL AUDITOR
EXECUTIVES

PROGRAMMING AND FUNDING CONTROL BRANCH

CONTRACTING OFFICE

SYSTEM PLANNING AND ENGINEERING DIVISION

SWITCHED NETWORKS IMPLEMENTATION DIVISION

TRANSMISSION MEDIA IMPLEMENTATION DIVISION

CCIS IMPLEMENTATION DIVISION

SYSTEM SUPPORT GROUP

MANAGEMENT SUPPORT GROUP

P.M. VOICE NETWORKS
P.M. DATA NETWORKS
P.M. CRYTO

P.M. SATCOM
P.M. TERRESTRIAL TRANS.
P.M. ORDER WIRE AND CONTROL FACILITIES

SOFTWARE MAINTENANCE AND DEVELOPMENT CENTRE (EVERE)
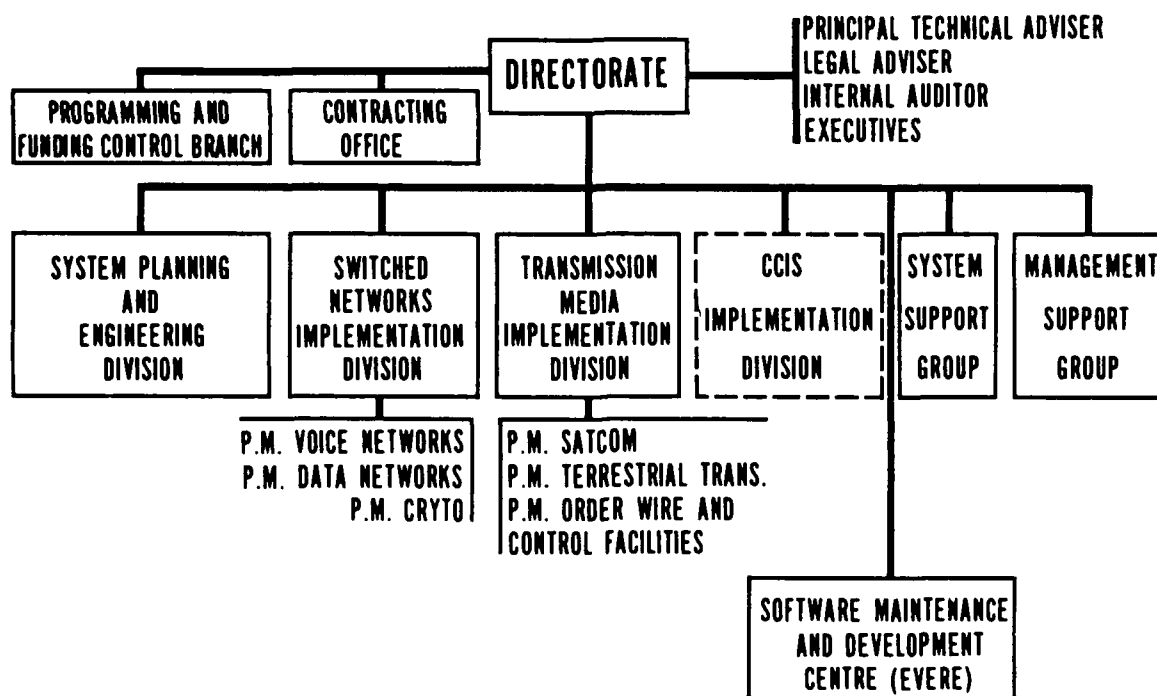
Figure 2

CIVIL AND MILITARY STRUCTURE

NATO International Staff

FIGURE 3

SECRETARY GENERAL CHAIRMAN OF THE COUNCIL AND DPC

DEPUTY SECRETARY GENERAL

PRIVATE OFFICE

OFFICE OF THE SECRETARY GENERAL

| OFFICE OF THE LEGAL ADVISER | EXECUTIVE SECRETARIAT | OFFICE OF SECURITY |

OFFICE OF THE FINANCIAL CONTROLLER

OFFICE OF MANAGEMENT AND OF ADMINISTRATION AND PERSONNEL

DIVISION OF SCIENTIFIC AFFAIRS
- SCIENCE PROGRAMME OPERATIONS
- SCIENCE PROGRAMME DEVELOPMENT
- CHALLENGES OF MODERN SOCIETY

DIVISION OF INFRASTRUCTURE, LOGISTICS AND COUNCIL OPERATIONS
- INFRASTRUCTURE
- LOGISTICS
- COUNCIL OPERATIONS

DIVISION OF DEFENCE SUPPORT
- ARMAMENTS AND DEFENCE RESEARCH
- PLANNING AND SUPPORT
- COMMAND CONTROL AND COMMUNICATIONS
- AIR DEFENCE SYSTEMS

DIVISION OF DEFENCE PLANNING AND POLICY
- FORCE PLANNING
- NUCLEAR PLANNING
- CIVIL EMERGENCY PLANNING

POLITICAL DIVISION
- POLITICAL AFFAIRS
- ECONOMICS
- INFORMATION
- PRESS

NATO Military Structure

FIGURE 4

MILITARY COMMITTEE
MC

INTERNATIONAL MILITARY STAFF
IMS
Brussels

Abbrev.	Description
NCCD+C	NATO Command and Information Systems and Automatic Data Processing Committee (Brussels) *
NCEB	NATO Communications - Electronics Board (Brussels)
ACSA	Allied Communications Security Agency (Brussels)
ALLA	Allied Long Lines Agency (Brussels)
ARFA	Allied Radio Frequency Agency (Brussels)
ATCA	Allied Tactical Communications Agency (Brussels)
ADSIA	Allied Data Systems Interoperability Agency (Brussels)
MCCISWG	Military Command, Control and Information Systems Working Group (Brussels) *
MCEWG	Military Communications - Electronics Working Group (Brussels)
ANCA	Allied Naval Communications Agency (London)

SUPREME ALLIED COMMANDER ATLANTIC (SACLANT)
Norfolk
USA

ALLIED COMMANDER-IN-CHIEF CHANNEL (CINCHAN)
Northwood
U.K.

CANADA U.S. REGIONAL PLANNING GROUP (CUSRPG)
Arlington
USA

SUPREME ALLIED COMMANDER IN EUROPE (SACEUR)
SHAPE
Casteau
Belgium

SACLANT ANTI-SUBMARINE WARFARE RESEARCH CENTRE (SACLANTCEN)
La Spezia
Italy

SHAPE TECHNICAL CENTRE (STC)
The Hague

NATO DEFENSE COLLEGE (NADEFCOL)
Rome

NATO ELECTRONIC WARFARE ADVISORY COMMITTEE (NEWAC)
Rome

MILITARY AGENCY FOR STANDARDISATION (MAS)
Brussels

NATO TRAINING GROUP (NATO TRAINING)
Bonn

ADVISORY GROUP FOR AEROSPACE RESEARCH AND DEVELOPMENT (AGARD)
Paris

MILITARY COMMITTEE METEOROLOGICAL GROUP (MCMG)
Brussels

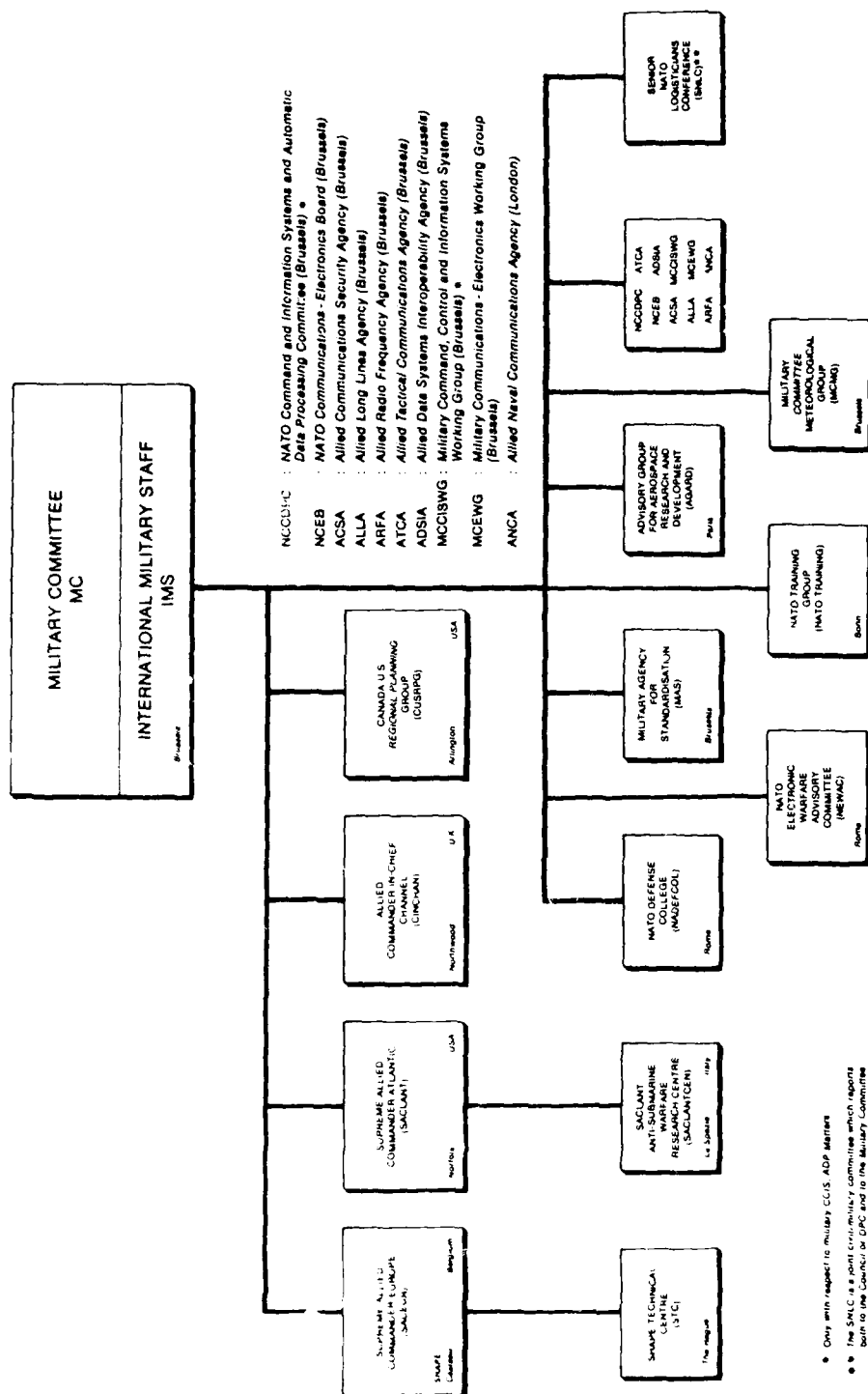| NCCDPC | ATCA |
NCEB	ADSIA
ACSA	MCCISWG
ALLA	MCEWG
ARFA	ANCA

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THE INFORMATION NEEDS OF SCIENTISTS AND ENGINEERS
IN AEROSPACE

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A brief description of a recent research project to ascertain the communication and information-seeking and use habits of scientists and engineers working in aerospace research establishments and other organizations is given. Relevant organizations studied include DFVLR, NLR, CNES and ESA. Following an overview of the basic characteristics of scientists and engineers, a review of the project's major findings as they relate to the type of information required by scientists and engineers, its availability, the sources - both oral and written - from which the information is obtained and the scientists' and engineers' awareness of them, how they keep up-to-date, the time spent seeking information, the use made of the library and the communication patterns of scientists and engineers, is then given. Some general suggestions for improving the communication and information flow within organizations to the satisfaction of practicing scientists and engineers are made.

INTRODUCTION

The European Space Agency (ESA) is an international organization which directly handles research and development projects, unlike certain other international organizations which have a more administrative, paper-pushing or mail-box role. Because of this, it was considered useful to see how the staff of some 600 scientists and engineers at ESA's main research and development establishment - ESTEC - ir The Netherlands compared with other organizations having similar roles in matters of communication and information use. A study was thus carried out to find and explain the facts surrounding the formal and informal information-seeking behaviour of scientists and engineers in a multi-national government environment. The study attempted to discover the communication channels most often used, the extent of communication with others, the nature of the communication and the use of the library or information centre in fulfilling information needs.

Fourteen organizations were approached for inclusion in the study - seven international organizations and seven national aerospace establishments. Out of the fourteen organizations invited to take part, six finally agreed to do so - three international organizations and three national aerospace establishments. The former were ESA-ESTEC, UNESCO in Paris, France and the International Atomic Energy Agency in Vienna, Austria. The latter were the Nationaal Lucnt- en Raumtevaartlaboratorium (NLR) in The Netherlands, the Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt (DFVLR) in West Germany and the Centre National d'Etudes Spatiales (CNES) in France.

The overall objective of the work, then, was to study the patterns of communication and information-seeking and use of scientists and engineers working in an international organization oriented to space research and exploration (the European Space Agency) and to see how the results compared with a) other international organizations and b) other government-oriented aerospace organizations. A better understanding of the scientific and technical information flow in such bureaucratic organizations and the reactions of staff to it, could lead to greater economies and efficiency.

Survey research was used to obtain feedback from the scientific and technical staff in these international organizations and national aerospace research establishments located in Europe on their methods of communication and their information-seeking habits. The data was gathered by means of a questionnaire consisting of mainly closed menu-type questions to save the time and effort of the respondents. A number of open questions were also included. Before being circulated the questionnaire underwent a number of pilot studies to try and achieve optimum comprehensibility and clarity. In two organizations (UNESCO and ESTEC) the questionnaires were sent directly to the individuals, while in the other four participating organizations they were sent to a focal point (the librarian) for subsequent distribution within the organization. The number of questionnaires distributed to the six organizations was 1107 of which 287 (25.93%) were finally returned after follow-up letters and phone calls. The questionnaires were analyzed by computer using the SPSS program.

DIFFERENCES BETWEEN SCIENTISTS AND ENGINEERS

Engineers are responsible for formulating basic technical concepts, transforming them from ideas into physical entities, adapting resulting products to specific applications and evaluating their usefulness. They are thus more oriented towards applications rather than the generation of new concepts and theories leading to an increase in knowledge, which is the domain of the scientist. Science is concerned with knowledge for its own sake and with the search for truth, whereas engineering is concerned with creating devices that will be useful. The engineer is thus the medium by which the public enjoys the fruits of scientific research.

While engineering on a technical level is closely related to and interdependent on science, there are distinct differences between science and engineering which must be appreciated. Engineers differ from scientists in their professional activities, their attitudes, their orientations, their academic educational process and even their typical family backgrounds, as well as in their information use and communication patterns.

The striking contrasts in communication behaviour patterns between scientists and engineers can be traced to fundamental differences in group organization and motivation. The scientist sees himself as belonging to an amorphous group of fellows who share his research interests and attitudes regardless of their organizations and geographical locations. In contrast, the engineer/technologist works for organizations

that are product/profit-oriented, which control the work (to create or improve products) and which do not permit, for competitive reasons, free communication between members engaged on propriety research and people outside the organization. Because of the nature of his work, which is not contributing to theoretical advances and an increase in general knowledge, the engineer will tend more to publish his results in internal reports and memos rather than in journals read by the scientific and technical community at large. He is thus results-oriented rather than information-oriented. As a consequence of this, the engineer is not closely connected to the formal communications media and thus has no pressing need to read journals. Technologies do have their own journal systems, like science, but the literature does not cumulate and build on itself the way science does. It contains fewer references to other work and the work reported serves to document end-products rather than announce theories.

INFORMATION NEEDS OF SCIENTISTS AND ENGINEERS

The study questionnaire asked about the requirements for facts, ideas, advice and opinions. The percentage of respondents requiring each type fairly or very often was 64% for facts, 23% for ideas, 10% for advice and 8% for opinions.

Facts were very often needed by 64% of the respondents and not very often or rarely by only 7%. Scientists needed facts only slightly less often than engineers, though in the national aerospace establishments, the number of scientists requiring facts very often was quite a bit lower than those in international organizations (54% to 64%). Among the highest users of facts were chemists (83% in international organizations and 67% in aerospace establishments), those in space technology (82% in international organizations and 61% in aerospace establishments) and those in management (72% in international organizations and 60% in aerospace establishments). A relatively low 57% said they wanted facts with any degree of urgency, with scientists in both types of organization being less bothered about the time factor than engineers.

Ideas - conceptual information - were required both very often and not very often by only one quarter of the respondents. Scientists, particularly chemists and life scientists, in aerospace establishments wanted ideas the most; while out of the engineering group those in telecommunications in international organizations were the most eager for new ideas. Conversely, just over a quarter of the latter said that they did not need ideas so often as did one quarter of those in management.

Less than 10% of the respondents wanted advice or opinions in their work - with, in fact, 40% specifically stating they did not require them at all. Engineers in international organizations were slightly more inclined to accept advice and opinions than scientists, although this position was reversed in aerospace establishments, heavily so in the case of opinions, where 12% of the scientists (predominantly life scientists) had a requirement for opinions compared to only 3% of engineers.

The respondents were asked to indicate what kinds of information required by them they could not get from the library in their organization. By far the highest type of information needed was day-to-day project-related information, next came literature, particularly from within the organization, then specific technical and experimental data.

In general, engineers required project data more than scientists, while the latter required more literature and experience. In particular, the earth scientists in aerospace establishments needed experience far more than their counterparts in international organizations. Those in space technology in both organizations required a high degree of project information, as did those in management, particularly in aerospace establishments, where over double the number of those in international organizations needed it. Interestingly enough, while chemists and life scientists appeared quite heavily involved in projects, earth scientists and physicists were not.

SOURCES OF INFORMATION

The overwhelming conclusion from an analysis of the results of the survey was that the main source for information needed on a one-time basis, on a continuing basis or for keeping up-to-date, was colleagues and the main channel was oral - i.e. personal contact. 45% of the respondents normally obtained needed information from colleagues in their own division. For information not available from the library, 58% turned to personal contacts, the originator, and contractors. To keep regularly up-to-date with what was going on in their field 39% preferred talking with colleagues at work.

The colleague or personal contact as a source of information is again emphasized by noting the other oral channels employed - 23% obtained needed information very often from colleagues working on the same project, though not in the same division; 18% got information very often from people outside the organization; 9% got information very often from other colleagues within the organization, i.e. working on a different project and in a different division; while 14% kept up-to-date by attending conferences and hence meeting people there. There was virtually no difference between scientists and engineers in the use of oral sources.

In the main, the present survey found that the source of literature used the most frequently was reports - some 30% saying they used reports very often compared to only 16% who replied they rarely used them. Nearly half the respondents rarely used books and conference papers. One third used journals very infrequently. Standards and abstract journals were also not greatly used. In most cases the engineers used every source more frequently than the scientists in international organizations, except for abstract journals. In aerospace establishments, the scientists (particularly life scientists), beside abstract journals also made greater use of textbooks, journal articles and meeting reports.

Of course, using information sources is one thing - knowing about them is another. In general, while a majority (66%) of respondents felt they were sufficiently aware of sources of information in their field, a minority (41%) felt they adequately covered them. Staff in international organizations were slightly more aware of sources than their counterparts in aerospace establishments though they covered them less. Those in non-supervisory positions tended to be more aware of their sources than those in supervisory positions and also covered them better. Scientists tended to be more aware of information sources than

engineers. 75% of all scientists (the figure rose to 83% for scientists in aerospace establishments) were aware of their sources, compared with 63% of all engineers - though engineers tended to cover them to the same extent - 42% saying they did cover them well enough, compared to 42% likewise for scientists. The latter figure was much more pronounced in aerospace establishments where 62% of scientists felt they covered them adequately compared to 33% of the scientists in international organizations.

For the vast majority of respondents non-availability of needed information from the library did not cause them any concern - they had their own sources and these were chiefly personal contacts. In fact, given a number of potential problems in getting the information needed to solve problems or complete tasks, only a handful of people said they had any difficulties. The one causing the most problems was the delay in getting hold of information - 9% said this was very often a problem.

TIME SPENT SEEKING INFORMATION

It can be inferred from the study that scientists and engineers do not keep as current as they could because a) they do not adequately cover the information sources of which they are aware and b) they do not spend sufficient time on information-seeking.

While not asking for the actual amount of time spent seeking information the questionnaire did elicit that 69% did not spend as much time as they would like on the task. People in aerospace establishments were more satisfied with the time they spent than were those in international organizations. Scientists, particularly in aerospace establishments, spent more time seeking information than engineers - though only one third of these scientists and one quarter of the engineers were satisfied they spent enough time.

Generally speaking, 56% said they did not adequately cover the sources of information in their fields - but of these no fewer than 60% read for less than two hours per week on average. Conversely, of the 41% who did feel they covered information sources adequately, 52% spent more than two hours a week on average in background reading. Overall, 54% spent two hours or less a week in background reading - more respondents in international organizations spending up to two hours than in aerospace establishments (57% compared to 48%). Scientists tended to spend a little more time than engineers in background reading - 50% reading for three hours or more compared with 43% of engineers - though a slightly higher proportion of engineers (17%) spent more than six hours a week in background reading compared to scientists (15%).

Regarding the need for facts 43% spent as long as was necessary seeking the information they needed, and 22% did not spend long at all on the task. There were no real differences between scientists and engineers, nor between the two types of organization - though non-scientists/engineers in international organizations were willing to spend the most time collecting the necessary facts.

USE MADE OF LIBRARY FACILITIES

The main reason given by the respondents for visiting the library was to scan new journals - scientists in aerospace establishments doing this more frequently. The implications here are that either journals were not circulated within the establishments or if they were, then they took so long that it was better to read them in the library before they went out on circulation. The second most popular reason for visiting the library was to borrow documents. Few went to request or carry out themselves a literature search.

It can perhaps be assumed that the average scientist or engineer used the library more to see what new books and journal issues were available rather than as a real source of information. This is borne out by the replies to a question which asked whether most of the information needed for work purposes was obtained from the library. A hefty 71% gave a resounding NO. (38% were engineers and 21% were scientists).

The kind of information which respondents required and which they could not get from the library were noted above. Briefly, they were project-related, day-to-day details, literature, technical data, administrative data and experience. Of those that replied to the question "do you feel the library should be able to supply this kind of information?" (i.e. the information they said they could not get), 59% said no and only 10% responded yes.

Undoubtedly, this is a major reason why the library is not frequented so often. 60% of the respondents visiting it less than once a week - those in aerospace establishments being the less frequent visitors. The study found that virtually half the respondents spent less than fifteen minutes in the library at any one time.

Just as those in supervisory positions visited the library less, so they also spent less time there - 53% spending less than 15 minutes there and 15% spending over thirty minutes, compared to 45% and 23% respectively of those in non-supervisory positions. In addition, 50% of those aged forty-five years and over also spent less than fifteen minutes there at any one time. Staff in aerospace establishments spent quite a lot longer time there than staff in international organizations and while engineers spent less time in the library than scientists in general, engineers in aerospace establishments spent more time there than scientists in international organizations, though not as much as scientists in their own establishments. 50% of engineers spent up to fifteen minutes in the library at a time, compared to 44% of scientists.

COMMUNICATION HABITS OF SCIENTISTS AND ENGINEERS

Staff were asked to give their communication habits over a six-month period. 50% of the respondents indicated they spent less than one third of their time communicating, while 8% spent over two-thirds.

The activities on which a majority of people spent a large amount of time were speaking on the telephone (22%) and visiting colleagues in their offices (19%) - both informal means of communicating. Among the

formal communication activities, the one most people spent most time on was in meetings with contractors. Not much time was spent in formal presentations, staff meetings, committee meetings and brain-storming sessions.

It appeared that people spent most of their time in written communication rather than oral. 16% spent at least two-thirds of their time in writing memos and telexes as well as in preparing internal reports. It was considered that staff in national aerospace research establishments would, because they were taking part in multi-national as well as national projects, have a fair degree of contact with contractors. It came as a surprise, therefore, to find that only 6% of the engineers in the aerospace establishments indicated they spent much time on contractor/consultant meetings. In international organizations the corresponding figure was 21%. For scientists the figures were much closer - 12% and 16% respectively. Similarly a higher proportion of engineers in international organizations (14%) spent over two-thirds of their time in progress meetings compared to 6% of engineers in the aerospace establishments.

It was deduced from an analysis of results that the average scientist or engineer communicated several times a day, for less than thirty minutes a time, with peers working in the same division on the same project and in the immediate vicinity. The basis for the contact was likely to be the qualifications and experience of the colleague and the initiation of the contact was done on a fifty-fifty basis. The usual nature of the contact is technical discussions for problem-solving with hard facts being the information mainly transferred. The encounter will be face-to-face in the office or laboratory of either colleague.

It was clear that people preferred to discuss matters and exchange information in a face to face mode where they could gauge the other's facial features and movements for further feedback and clarification.

SUGGESTIONS FOR IMPROVING COMMUNICATION AND INFORMATION FLOW

With so small a sample it is obvious that the study results cannot speak for all scientists and engineers in international organizations and national aerospace establishments. Nevertheless, the results can be considered indicative of their patterns of communications and information use. The suggestions or recommendations which follow are, therefore, directed to any organization wishing to improve its communication and information flow and thus contribute to greater savings and efficiency.

Recommendation 1 :

The library should actively stimulate a much greater awareness of information within the organization

Recommendation 2 :

The library should conduct a study to ascertain actual and potential users' real needs and requirements and information-seeking behaviour.

Recommendation 3 :

The library should aim to provide a superlative service to those who need and use its services the most.

Recommendation 4 :

Notwithstanding Recommendation 3 above, the library should aim to do more for managers, who, the survey showed, were poor library users.

Recommendation 5 :

The library should prepare, and subsequently evaluate, programmes of user education and training in information sources and use.

Recommendation 6 :

A study aimed at finding out how and why staff spend their time in the office should be undertaken.

Recommendation 7 :

The amount and flow of document preparation, copying and distribution should be measured.

Recommendation 8 :

The feasibility of installing an electronic storage and messaging system within the organization based on a local area network (LAN) should be studied.

Recommendation 9 :

Gatekeepers and boundary-spanning activities should be actively encouraged.

Recommendation 10 :

The organization should encourage and actively try to achieve a greater interaction and exchange of information between its diverse divisions and groups.

Recommendation 11 :

Management should strive to create better conditions for interpersonal communication and information use given their importance and effect in improving R&D innovation and performance.

Recommendation 12 :

The feasibility should be investigated of integrating under a single information resources manager the various departments dealing with information functions (such as the library; communications (mail/telex); reproduction/printing; publications; public relations; photographic/graphics; archives; computer department).

INFORMATION SERVICES - PROS AND CONS

by

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A strong science and technology base is a national necessity in a competitive world, and adequate communication is a prerequisite for it. An individual, be it a policy maker, program manager, a bench scientist or engineer resorts to the information system if he believes it will save him or her time to first consult the written record rather than to undertake a repetitious experiment or investigation. The three components to an effective information service are the sources (those who provide or produce information), the users (those who need the information) and the professional information specialists (those who bind the whole system together). The cooperation toward information exchange of all those connected with research and development must be enlisted in support of the system of which they are a part.

In October, 1983, the President's Private Sector Survey on Cost Control, better known as the Grace Commission, made the following observations in its Task Force Report on Research and Development:

"Savings from improved resource management [in Federal Research Laboratories] are estimated to be $153.0 million in the first year, $168.3 million in the second year, and $185.1 million in the third year for three-year total savings of $506.4 million."

"The Task Force conservatively estimates that implementation of a centralized data base containing records of all non-classified, Federally funded, completed and on-going R&D projects will reduce unnecessary program redundancy in basic and applied research by a minimum of 0.5 percent in the second year and by 1.0 percent by the third year."

Another report, published in March 1984, entitled "Scientific and Technical Information Transfer: Issues and Options" addresses the concern of Federal policy makers that the information created through the billions of dollars spent annually by the Federal Government is not well utilized because of inadequacies in information transfer between the researcher and user communities.

Problems contributing to this concern are: (1) the very low level of support for knowledge transfer in comparison to knowledge production suggests that dissemination efforts are not viewed as an important component of the R&D process; (2) there are mounting reports from users about difficulties in getting appropriate information in forms useful for problem solving and decision-making; and (3) rapid advances in many areas of science and technology can be fully exploited only if they are quickly translated into further research and application. Such translation requires multidisciplinary, problemfocused communication of scientific information.

Federal agencies have attempted to increase the flow of information chiefly by improving its availability. As a result, applied scientists, decision makers, and other users are now faced with an enormous quantity of potentially pertinent research results available in published form and through on-line services. However, two problems remain: (1) mechanisms are inadequate to help the user assess the quality of available information; and (2) the characteristics of actual usage behavior are not sufficiently taken into account in making available useful and easily retrieved information. Difficulties include the lack of interactive knowledge transfer systems and "cultural" differences between information producers and potential users.

Users rely on two major systems for acquiring scientific and technical information: (1) formal document distribution and (2) informed contacts with colleagues. Formal search services often comprehensively retrieve materials, but they may fail to identify those of greatest significance. The interactive and informal collegial system is more timely in providing information about current research and its potential significance, and is therefore better focused on user needs. But it is not necessarily comprehensive, since individuals are unaware of information resources that do not enter their collegial networks.

A recent report (19 Mar 85) prepared by the Office of the Inspector General, Department of Defense, revealed that all military departments had issued implementing guidance requiring that a literature search be performed during the planning stages of new contracts to ensure that proposed efforts did not duplicate other research in progress as completed. The Inspector General report revealed that laboratory personnel had documented evidence of literature searches for only 17 percent (811 of the 4,774 work units) of

new research contracts awarded. As a result, it was estimated that 95 contracts valued at $32.6 million out of a universe of 4,774 contracts valued at $1.9 billion reported as completed in Fiscal Years 1982 and 1983 duplicated other DOD research efforts. Laboratory personnel provided the following reasons that no written documentation was available for the remaining 3,963 work units:

o Literature searches were made, but documentation was not retained (35 percent);

o Literature searches were unnecessary because laboratory personnel were aware of all ongoing and past research in the areas involved (17 percent);

o Literature searches were not made because the technical information center's data base was not considered current (11 percent);

o Literature searches were unnecessary because the research was considered unique to that specific laboratory (2 percent);

o Literature searches were not made because the requirement was not enforced by laboratory management (18 percent).

Nonetheless, a number of problems remain in assuring the availability of scientific and technical information. Five principal ones have been identified:

1. Many potential users are unaware of much of the information available to them. A General Accounting Office survey of managers in Government information centers revealed that 63 percent knew about scientific and technical data bases duplicating their own. The report attributes this condition in part to lack of awareness of existing data bases when creating new ones. Further, many information systems are seriously underutilized primarily because of the lack of information about available databases. Agency personnel who work with data users report that for every actual data user they encounter, they find many others who need information but are unaware that it is available, or else are unable to find out where the information exists. Finally, it is likely that small firms and local Government agencies are at a disadvantage in obtaining scientific and technical information; moreover, research suggests that they are in the main, unaware of the serious information gap they face.

2. The second principal problem is that many potential users are discouraged by the complexity and cost of obtaining information from abstracting and indexing services. Several sources attest to the burgeoning complexity and cost of the abstracting and indexing systems created to make information retrieval simplier and easier. In 1950, the cost for subscribing to "Chemical Abstracts" was about $300 a year for 50,000 abstracts. In 1976, the cost was about $3,500 and included over 450,000 items. By now, the subscription costs more than $62,000 annually and includes over 34,000 new items each month. Such changes have required users to dramatically alter their strategies for becoming or staying informed in a field. Needless to say, scientific and technical information is voluminous, fragmented, conflicting, and obscure.

The costs of access in terms of time and effort as well as budget are such that a common solution is simply to ignore relevant scientific and technical information. Consistency, clarity, and appropriateness of key words and formats for searching bibliographic data bases are mentioned as serious problems. In a large scale survey of engineers and scientists, nearly half the respondents mentioned difficulties with search formats, retrieval structures, ability to use key words to get desired information, and other system access issues. Other problems arise in relation to abstracts. Sometimes they are not available at all, and in other instances they are so incomplete as to be of little more value than the title itself in indicating what kind of information is available in the indexed material.

To take advantage of online information sytems, the user also has to be assured of the following:

o availability of a computer terminal;

o adequate connect time;

o subscriptions to an array of bibliographic services;

o skill in using the services (either directly or via an information professional);

o ability to acquire an item of information once it has been identified;

o funds to cover expenses that these efforts entail (in labor, equipment, and services).

All of these requirements, together with system shortcomings, constitute a formidable set of access limitations for many potential users of the body of scientific and technical information that is, in principle, publicly available.

3. The third principal problem is that dissemination of research products is

narrow. Research tends to be disseminated within small, homogeneous audiences or within scientific and technical disciplines. Formal information transfer channels, including both primary product distribution and secondary information resources, tend to be organized along traditional disciplinary lines. Between-group differences in language, norms, and values create communication barriers often analogized to cultural differences. Also, collegial contact networks are organized along disciplinary lines. Dissemination across disciplines does not occur readily, and transfer of information from academic sources to nonacademic audiences is even more impaired.

Sometimes dissemination systems work within boundaries even more restricted than those of a subdiscipline. For example, technical reports produced by private laboratories usually receive no circulation outside the sponsoring organization. Reports produced within academic or public research institutes may receive wide initial distribution but rarely enter formal channels for archiving and future delivery. Further, attempts to broaden dissemination fail if user needs are not taken into account. One-way, untargeted distribution efforts may only result in the accumulation of unused materials at the receiving end.

4. The fourth principal problems is that formal information transfer systems are not timely enough. A number of studies have demonstrated that information potentially available in the early stages of projects is often not found until too late to be useful. However, what is timely has been found to vary depending on the nature of the information need. It is generally agreed that, for users who are themselves engaged in research and development, the results of others' work often help them improve their own conceptualizations and can be of value even very late in a project. On the other hand, for users who are engaged in application or administration, information must be acquired very early if it is to be helpful. While computer-based methods have helped to expedite publication and updating of information as well as its location and retrieval, the process typically does not move rapidly enough to meet the needs of applied scientists or decision-makers. Reporting, publishing, abstracting, and indexing take a considerable amount of time. Thus, informal contact networks are invoked when information needs are immediate. By these channels, users receive preprints of reports and learn the most recent results of relevant work in progress. Timeliness, then, is a criterion more often met by informal information transfer procedures.

5. The fifth and last problem identified in assuring the availability of scientific and technical information is that the continuity of abstracting and indexing systems is threatened by budgetary constraints. Traditional scientific journals provide continuous access to research knowledge. Continuity of access via secondary information sources and services is subject to several constraints. The first is the fact that information data bases can be difficult to find. Second, many sources have called attention to the uncertainty and changeability of the information policy environment of which dissemination processes are a part. Policy variability creates planning problems both for information service providers and for potential users.

Most important, however, are curtailments of services, such as the termination of the former Smithsonian Scientific Information Exchange and the earlier Office of Scientific Information Services. It has recently been argued that Federal information agencies provide tax-supported, underpriced services that could be more efficiently and fairly supplied by the private sector, with the users paying full costs. Some Federal data bases do compete with private sector products, and commercial search services have sometimes bought Federal data bases only to find it difficult to sell what the Federal services price so low. The distribution of responsibilities between the private sector (for-profit and not-for-profit) and the public sector, as well as marketing philosophies for Federal information, remain unresolved.

In January 1963, a report of the President's Science Advisory Committee was published, entitled "The Responsibilities of the Technical Community and the Government in the Transfer of Information," better known as the Weinberg Report. We consider that report to be the basis of establishing our Department of Defense Scientific and Technical Information Program (STIP). In summary, the report stated that:

Transfer of information was an inseparable part of research and development. All those concerned with research and development--individual scientists and engineers, industrial and academic research establishments, technical societies, Government agencies--must accept responsibility for the transfer of information in the same degree and spirit that they accept responsibility for research and development itself.

The technical community generally must devote a larger share than heretofore of its time and resources to the discriminating management of the ever-increasing technical record. Doing less will lead to fragmented and ineffective science and technology.

The Committee made the following recommendations:

1. The technical community must recognize that handling of technical information is a worthy and integral part of science. We shall cope with the information

explosion, in the long run, only if some scientists and engineers are prepared
to commit themselves deeply to the job of sifting, reviewing, and synthesizing
information; i.e., to handling information with sophistication and meaning, not
merely mechanically. Such scientists must create new science, not just shuffle
documents: their activities of reviewing, writing books, criticizing, and
synthesizing are as much a part of science as is traditional research.

2. The individual author must accept more responsibility for subsequent retrieval
of what is published. Individual scientists and engineers must participate in
the information transfer process, rather than leaving the entire responsibility to
the professional documentalist. We therefore urge authors of technical papers to-

    a. Title papers in an informative manner;

    b. Index their contributions with keywords taken from a standard thesaurus;

    c. Write informative abstracts;

    d. Be concise.

3. Techniques of handling information must be widely taught. Familiarity with
modern techniques of information processing is necessary for the modern scientist
and engineer. Our colleges and universities must provide instruction in these
techniques as part of the regular scientific curriculum. They must also educate
in the art of handling information more professionals who can lighten the burden
of the technical man and can invent new techniques of information retrieval.

4. The technical community must explore and exploit new switching methods.
The information transfer network is held together by an array of switching
devices that connect the user with the information (as contrasted with the docu-
ments) he needs. As the amount of information grows, more ingenuity will be
needed to find effective switching mechanisms, if only because the capacity of the
human mind places a limit on how much information can be assimilated. The technical
community must courageously explore new modes for information processing and
retrieval. Among the schemes that ought to be exploited more fully are:

    a. Specialized Information Centers made accessible to users everywhere, e.g.
thru a gateway mode. The Panel sees the specialized information center as
a major key to the rationalization of our information system. Ultimately
we believe the specialized center will become the accepted retailer of
information, switching, interpreting, and otherwise processing information
from the large wholesale depositories and archival journals to the individual
user.

    b. Central Depositories. The central depository to which authors submit
manuscripts that are announced and then distributed on request may ease
the technical problems of switching documents quickly and discriminatingly
between user (particularly the specialized center) and source.

    c. Mechanized Information Processing. The Panel recognizes that mechanical
equipment offers hope for easing the information problem. Commercially
available equipment is not the remedy in every case; economics, size,
frequency of use, growth rate, depth and sophistication of indexing must
be examined in detail for each collection before a specific system is
to be mechanized.

    d. Development of Software. Hardware alone is not a panacea for difficulties
of information retrieval. Software, including methods of analyzing,
indexing, and programming, is at least as necessary for successful infor-
mation retrieval.

    e. Standardization and compatibility are desirable. Since the entire information
system is a network of separate subsystems, rapid and efficient switching
between the different elements of the system is essential. Such switching
will be fully effective only if the different subsystems adopt uniform
practices toward abstracting and indexing.

The DOD Scientific and Technical Information Program (STIP) was established as a basic
and integral part of the Under Secretary of Defense for Research and Engineering
function. Specifically, I, as the Director of Research and Laboratory Management,
have been appointed to ensure that a coordinated, comprehensive STIP is established
and pursued within DOD. The principal objectives of the DOD STIP are:

    o to improve the scope and effectiveness of collecting, processing,
disseminating, and applying scientific and technical information.
The overriding priority of the STIP is to ensure that all STI concerning
DOD research and engineering (R&E) programs is rapidly and effectively
exchanged among scientists, engineers, and managers;

    o to increase productivity and effectiveness of research and engineering
programs;

o   to improve our military capabilities through research and application
     of new technologies;

o   to avoid overlap and duplication of research and engineering efforts;

o   maximize use of R&D resources;

o   facilitate domestic technology transfer.

The STIP concept is to provide support to the Department of Defense, State
and local Governments, and to private industry through a coordinated structure
of decentralized activities, namely, the Defense Technical Information Center,
Information Analysis Centers, Information for Industry Offices, Offices of
Research and Technology Applications, and participation in the Federal Laboratory
Consortium.

The Defense Technical Information Center (DTIC) is the central clearinghouse
for the great amount of information generated within the scientific and technical
community of the Department of Defense. It contains collections of R&D in
virtually all fields of science and technology, involving subject categories
ranging from aeronautics to zoology. As DTIC defines its mission, it is to
answer three questions related to the R&D program of the DOD:

1.   What projects are being planned?
2.   What projects are currently being performed?
3.   What results were realized by completed programs?

Defense and associated contractor researchers are required to deposit infor-
mation into DTIC data bases for the subsequent retrieval for eligible users. R&D
activities within the US Government and their associated contractors, sub-
contractors, and grantees, with current Government contract are eligible to receive
most of the information from DOD data bases at DTIC. R&D activities without
current contracts may become eligible for DTIC services by a military authorization
under the Defense Potential Contractor Program.

DTIC is a service-oriented organization. It provides nearly all of its services
through use of various data bases which it maintains. DTIC also acts as the DOD
source for the secondary distribution of documents. In this capacity it reproduces
documents in both hard copy and microform, and will supply such documents to quali-
fied users. DTIC is a prolific publisher, producing its own manuals and documents.
Access to DTIC is by on-line searching or manual access.

Information Analysis Centers (IACs) are functional elements that collect,
review, digest, analyze, appraise, summarize, and provide advisory and other user
services concerning the available S&T information and data in well-defined,
specialized fields. IACs are distinguished from documentation centers and libraries,
whose functions are primarily concerned with the handling of documents rather than
the technical information contained in the documents. There are currently 22 IACs
which deal with such subjects as chemical propulsion, metals and ceramics, tactical
weapon guidance and control, metal-matrix composites, manufacturing technology,
aircraft systems survivability/vulnerability, shock and vibration, etc.

Each IAC is concerned with clearly-defined subject matter which may be:

o   discipline oriented - all or a clearly-defined part of a recognized
     scientific or engineering discipline which has its own literature or
     professional traditions, or;

o   mission oriented - a military undertaking of special interest to DOD
     or a specific large weapon system, and, therefore, an area which
     requires an interdisciplinary approach.

Each IAC has four functions, namely:

1.   To Gather Information. The input comprises the world's applicable scientific
and technical results drawn from published literature, unpublished documents, meetings
or symposia, personal visits, or from any other sources or media available, both
foreign and domestic. An aggressive acquisition program is a continuing require-
ment.

2.   To Analyze Information. In addition to a staff technically trained in the
field of specialization and in information processing, a distinguishing characteristic
is the use by the center of laboratory personnel working in the area of specialization
as consultants. This requires day-to-day contact between these specialists and
significant research and development activities in their field.

3.   To Evaluate and Condense. The critical process of evaluation involves
expert judgement of new information for value through analysis, comparison, and
appraisal relative to information previously acquired. Information is condensed,
summarized, and retained. The information is screened, filtered, and reduced to

meet user requirements ranging from highly condensed information for management to detailed information for bench scientists and engineers. This entails a continuous refinement of indexing and retrieval methods.

4. To Provide Individual User Services. Foremost, the center answers questions. Communications can consist of specific items of evaluated data or information, current summaries on technical trends, comprehensive state-of-the-art analyses, and specialized advisory services. Again, it should be noted that the center produces information in forms ranging from highly condensed information for management to detailed information for bench scientists and engineers. The center also provides services relating to identification and filling of gaps in information and to preparation of vocabularies or their area of specialization.

The Information for Industry Offices (IFIOs) have been established to provide a focal point wherein the industrial, scientific, and academic community can obtain information on DOD acquisitions, requirements, plans, and future needs. IFIOs maintain a current, up-to-date planning and technical requirements data base. These offices continually search for, collect, and incorporate updated DOD R&D planning information into their comprehensive file. The managers of IFIOs are conversant with industry needs, and relate these needs to appropriate information in their repository of planning documents. The IFIOs are also responsible for the management of the DOD Potential Contractor Program, whereby organizations not having a current DOD contract, can gain access to DOD S&T information in areas where they have a demonstrable capability to perform work for the DOD.

Offices of Research and Technology Applications (ORTA) have been established at all DOD laboratories to ensure the full use of the results of our investment in R&D. The ORTA is required to :

1. Prepare an application assessment of each R&D project which has potential for successful application in State and local Government or in private industry.

2. Provide and disseminate information on Federally owned or original products, processes, and services having potential application to State and local Governments and to private industry.

3. To cooperate and assist organizations which link the R&D resources of a laboratory and the Federal Government as a whole to potential users in State and local Government and private industry.

4. Provide technical assistance in response to requests from State and local Government officials.

All DOD laboratories are represented and participate in the Federal Laboratory Consortium, (FLC) which is an informal partnership of Federal research and development laboratories and centers. The FLC provides an interagency forum and national network, specifically designed to serve the member laboratories and their agencies. The role of the FLC is to assist its member laboratories in:

   o   development of effective technology transfer methods and mechanisms;

   o   transfer of Federally developed technology to domestic public and
       private organizations;

   o   application of Federal talent, where appropriate, to domestic public
       and private needs.

   o   establishment of networks with the rest of the scientific community
       in order to refer requests or engage in cooperative efforts.

A DOD STIP Steering Group has been formed whose function is to continuously analyze the DOD STIP and identify the character of work and the amount of resources required. The Steering Group maintains a systematic survey of the problems and needs of STIP users, and assesses the effectiveness of the STIP and its component functions in meeting these needs. Finally, the Steering Group establishes objectives, priorities, and policy for the STIP and its principal components.

To assist the Steering Group, three standing committees have been formed whose function is to assist the Steering Group in identifying problem areas and doing much of the Staff Work that results from Steering Group decisions. When necessary, Ad Hoc Working Groups are formed to address and staff specific problems of a larger scope or of long duration.

The three standing committees include:

1. The DOD Scientific and Technical Information Program Operations Committee.

This committee assists me in managing a coordinated, comprehensive S&T information program. They assist in preparing directives and instructions, reviewing the adequacies of DTIC services relating to the collection and distribution of informa-

tion, and assisting in the myriad administrative and operational tasks required in managing such a program. Membership is composed of representatives from all DOD components.

2. The Domestic Technology Transfer Committee.

This committee assists me in establishing policy guidelines to support the transfer of technology to the public and private sectors. They assist in preparing responses to Congressional oversight hearings and inquiries, review DOD participation in the Federal Laboratory Consortium, and in determining the types of assistance laboratories should provide to State and local Governments and the private sector. Membership is composed of the representatives from the military departments, Federal Laboratory Consortium, and the National Science Foundation.

3. The Information for Industry Committee.

This committee assists me in the management of the defense industry information program. Periodically, this committee meets with industry representatives to assess the effectiveness of the existing Information for Industry Offices. Membership is composed of representatives from the Military Departments: Army, Navy, and Air Force. Currently, some of the initiatives that the Steering Group, the Standing Committee and I are pursuing include:

1. Incorporate greater user responsibility and accountability in the development of effective S&T information systems.

2. Establish and publicize user education programs aimed at managers, scientists and engineers.

3. Promote "switching center" capability.

4. Provide wider spectrum of information services.

5. Combine information systems of similar kind or content.

6. Facilitate commonality and sharing of essential data by standardizing data elements and terms.

7. Structure systems to encourage horizontal, as well as vertical, sharing of information.

Because scientific and technical information is so intimate to the research and development effort, it must be the concern of the scientist, engineer, administrator, the laboratory director, the program manager, the information specialist- all have an obligation and responsibility to make the research and development process better and more effective.

The first responsibility is to make an input to the body of knowledge and information. Each project, each task in RDT&E has a result, moving us forward. Achieving the result is not the end point--the result must be made known. The finding from your work may be the key to success in another laboratory. The reservoirs of scientific knowledge and engineering results are full only because positive steps are taken to keep them that way. The scientists and engineers are making discoveries and getting results. The level of the reservoir is kept up when the discoveries and the findings are put into the body of literature and information.

Let me talk to the other side--it is called "take." This responsibility means that the scientists and engineers are alert to the work of thers and apply their results in doing the job. Being alert, knowing what is being done and the results from it depends again on them. While scientific and technical information is made available, it is not delivered to the laboratory until it is requested and used. The kind and amount of information needed is determined by the scientist and engineer. Tapping the reservoir and using it is just as important as keeping it supplied.

Another point I want to make to the scientists and engineers relates to the quality of the information that they put into the reservoir. In any specialized field of endeavor only the skilled are capable of separating the good from the bad. The engineer or scientist is the judge of the documents and information developed. He makes an assessment of the quality of the information developed. He makes an assessment of the quality of the information he has obtained from reservoir for his work. When the results of his project are documented he will have many different kinds of information and reports. Prudence requires that he make a judgment so that the worthwhile results are put into the information network. The project engineer who sends everything to the Documentation Center--without judging its value to the body of information--has not properly done his job. His job is to discriminate the good from the rest. No one is more qualified for this judgment than the R&D scientist and engineer. In his field of work he alone has the intellectual capacity to assess the reports and information. The objectives to guide his assessment should be to continually supply the reservoir with treasure and keep it free of trash.

There is one basic principle which must never be ignored. The information service is not an end in itself, but instead is a device by which its users obtain information to help solve their daily problems. As is true with most services, the user doesn't want to think about the mechanics or details of the service's operation. He only wants service of the type and degree that he wants, when he wants it, and at a reasonable price. In general, those responsible for operating an information service are quite cognizant of this principle and operate accordingly.

Finally, it is important for the management of an information service to look continually for quantitative measures of the effectiveness of the service. The value of information is difficult to determine, especially as one usually has to weigh short-term costs against long term benefits. Therefore, when a particularly large expenditure of time or effort is contributed by the information service, it is well to follow up the action by documenting results. Only in this manner can an information service be evaluated.

In closing, let me leave you with these challenges.

° To those of you who use information - program managers, administrators, scientists, engineers - help us to overcome the barriers that lead to incomplete data bases by ensuring that data bases are kept current with the appropriate information, properly indexed and catalogued. Remember to "do as you would be done by".

° To those of you who manage large and diverse resources - the top managers of agencies and industries - let me challenge you to resist the temptation of measuring costs and benefits purely in monetary terms. An opportunity lost, a delay incurred, an effort wasted, each represents a cost just as real as a dollar spent. On the other hand, a good idea exploited, a program completed earlier, a system improved, as a result of documentation made available, represents dollars saved, whether or not they can actually be counted.

° To those of you who handle scientific and technical information - the professional information specialist - help us to "sell" your program by demonstrating the services that you can provide to the user. Do this by documenting and sharing success stories with information users, and whenever possible, translating your success into dollars and cents as realistically as you can; let me or your AGARD Technical Information Panel member know about it. Remember, "by their fruits ye shall know them."

THE COSTS OF NOT HAVING REFINED INFORMATION

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SUMMARY

The adequacy of the information resources, which are called upon for support at decision points in the research-design-production-marketing process, can in part be measured by their scope, the presence or absence of information within that scope and, increasingly, by the extent to which they offer refinement in terms of the timeliness and quality of the information which can be retrieved. Timeliness in the present context relates not so much to the response time of the information system as to the extent to which that system is tuned to the volatility of the information which it contains. Likewise, the quality of information is not to be judged only by its relevance and authenticity but also by the convenience of its form of presentation in the view of the decision maker who has need of it.

The main focal points of the paper are the costs, disruption and other losses which arise from a lack of knowledge of previous work, the use of out-of-date technical information and, in particular, the extent to which the use of insufficiently refined numerical data leads to the under-, or over-, design of hardware. These are illustrated by a number of quantified examples. The transition from an industrially based to an information or service based society highlights the growing needs of the R&D decision maker and others for systems which will provide high quality numerical and factual data. However, substantiation of these needs may never be available in terms of evidence of direct future benefits as distinct from evidence of historic losses. More dynamic means of demonstrating the impact of information quality upon the interests of the decision maker must be devised and guidelines for two such projects are suggested.

INTRODUCTION

In his paper to a meeting of the Technical Information Panel some two years ago, George Hart (1) discussed the cost effectiveness of information services and their cost benefits. He spoke of cost effectiveness as the ability to provide the most effective service for least cost and cost benefits as the monetary value of a service in relation to its cost. Hart observed that much has been written on the former but that there has been very little attempt to 'grasp the nettle' of cost benefits. Certainly to the best of my knowledge attempts to evaluate, in practical terms, the benefits of having appropriate information have been limited. How useful it would be if one could demonstrate, unequivocally, the additional 'Return on Managed Assets' which a company will enjoy as a result of subscribing to the services of ESDU over a period of years! How useful it would be to the administrators of our national information services if they could arm their political masters with direct evidence of the enhanced returns which they induce from defence contract expenditures or from R&D investment.

Study of the cost benefits of having information, as distinct from the losses sustained by not having it, would be frought with difficulties. Not the least of these is that, in practice, no two teams are ever likely to attempt the same design, research or development enterprise, carrying it through to completion with all circumstances being identical other than that a certain set of information was available to one team which was not available to the other. Without strict observance of these conditions the results of any such study would be open to all manner of debate and opportunity for disbelief. In the absence of such causal evidence we resort, as I shall largely be doing in this paper, to post-mortem evidence of the losses, disruption or other consequences which result from someone not being aware of a set of information, or of having ignored that information, or of having misapplied it. There is plenty of well founded evidence of this type demonstrating beyond dispute catastrophic failures, extensive losses of time and money and disruptions of commercial and military advantage.

Many people have been distributing this evidence for some time, yet without any noticeable increase in the general appreciation of the value of quality information. I now believe that there are several reasons for this and to some extent, as I have written elsewhere (2), it may even be that the spectacular scale of some of the losses which can be demonstrated undermines their credibility or, at least, undermines the belief that such losses could ever occur again. There may also be another reason. Most, if not all, of the evidence of loss relates to the scientific and technical class of information and data. Yet those whose responsibility is for the financial or organisational well-being of our industrial establishment do not prioritise this class of information. Understandably, the decision making process at command level draws

more heavily on information on markets, or on the capability of military or commercial competitors, than it does on the information available to support research, design or development.

The Centre of Engineering Design of the Cranfield Institute of Technology surveyed captains of industry in relation to their priorities for the information needed in developing successful products (3). The top priority was for knowledge of the competition; 65% of respondents headed their lists with this requirement. Myers and Marquis (4) identified the major sources of information contributing to innovation in 567 new products and reported the major information impacts to have been:-

Market	related	factors in	45%	of	cases
Production	"	"	" 30%	"	"
Technical	"	"	" 21%	"	"
Administrative	"	"	" 4%	"	"

Such studies have recently been reviewed by the Technical Change Centre (5) in relation to the relative impacts of diferent sources of information on scientists and engineers working in industry and the mechanisms by which they acquire technical information.

The cost effects of information relating to markets or competitors are beyond the scope of this paper. Even if it they were not, I suspect that any demonstrations which could be given would be of losses incurred by not having information rather than of the financial benefits or military advantages of having information.

We will start by identifying some of the features of the problem of communicating and using scientific information and do this by reference to a fairly complete historical scenario. The part played by these features in causing losses and disruptions in some recent case histories will be examined and any which come close to demonstrating benefit subsequent to loss will be dissected. Then, rather than attempting to generalise conclusions in the hope of being able to derive cost benefit formulations, I will propose a rather different line of advance. It will be one which will involve decision makers themselves in revealing the advantages or dangers to which their current information resources expose them.

A LONG TERM CASE HISTORY

If we look at the information available in relation to a well defined technical question over a sufficiently long time-span we can see the characteristics of the problems which face researchers, developers and others, why they are often not aware of what has gone before and why they often fail to apply the best information available at any given time. Take, by way of example, the problem of estimating the strength in bending of a simple beam of rectangular section, Fig 1.

The first recorded estimation of the strength of a rectangular section beam was made towards the end of the sixteenth century by Galileo. His analysis gives a value 3 times that which would now be used for such a beam constructed of a material which was elastic up to the point of failure. As far as is known this was the only theoretical evaluation available to engineers for about the next hundred years or so. During this period it is doubtful whether any engineers were in fact using this information. Communication of scientific thought was not well developed; it was not until the following century that anything approaching reliable information transfer began via the Academies of Science. In hindsight we know Galileo's value to be wrong and why it was wrong. His result was defective because of lack of attention to the laws of elasticity. This fundamental gap in knowledge was filled by Hooke in 1678.

Mariotte's work (published after his death in 1686) took account of the elastic laws, even if not through knowledge of Hooke's work, and gives an estimation of the strength of the beam at a relative value of 2. It is closer than Galileo's value but still far from correct. Timoshenko (6), on whose history of events this scenario is based, demonstrates that Mariotte made an error in his analysis of the static equilibrium of the beam.

Nearly another century passed before Coulomb (1773) made a new evaluation, this time at a relative value of 1. His work made correct use of what was then known of the elastic nature of many common materials and of the laws of statics.

The interesting thing about Coulomb's work is that it repeated work done by another scientist, Parent, some 60 years earlier!

So during the eighteenth century, engineers had continued to use formulas based on Mariotte's evaluation until Coulomb's work was published in 1773. They were ignorant of Parent's work for some 60 years because, according to Timoshenko, Parent's results were not published by the Academy, they appeared in collected papers which were poorly edited and contained many misprints and his writing was obscure and difficult to follow.

In modern parlance, Parent's work was not 'user friendly'. Additionally, it appears, he was critical of other investigators and this made him unpopular with his fellow scientists. Human factors, such as these, are remarkably powerful barriers to the flow and use of information. Saint-Venant developed, circa 1864, a more refined theory for the bending of beams though no practical use of the results appears to have been made. This was probably due to the difficulty of relating his assumed stress distributions to the properties of actual materials.

For all practical purposes Coulomb's evaluation stood well into the present century and, with the use of appropriate safety factors, underwrote much of the structural design of the industrial revolution. It did so because most of the materials used in that period corresponded fairly closely with the elastic model on which Coulomb's research had been based. Also, materials were relatively cheap and the luxury of overdesign could be indulged. This indulgence is not unknown today despite Baker's and Prager's re-appraisals in the mid 1940's which brought the value back up to 1.5. A further re-evaluation by Barrett in the 1960's, following earlier semi-empirical evaluations by Cozzone and others, showed 1.5 to be an upper limit and that a new group of parameters had to be incorporated in the analysis to represent the wider range of materials then being used in critical situations.

The story does not end there, of course, but we have seen enough to illustrate most of the features which explain why, in hindsight, the best information was not available or was not used. These features are common to a wide range of technical problems and may be summarised as follows:-

Information resources are tainted by being:-

Incomplete	– Galileo/Saint-Venant
Prone to error	– Mariotte
Not communicated	– Parent
Obscure/not authoritative	– Parent
Clouded by human factors	– Parent
Accepted as adequate in the absence of overt commercial pressures	– Coulomb
Limited in scope	– Baker/Barrett

All of these factors must be assumed to affect the information available on almost any technical problem which exists today. Though we cannot evaluate the losses in financial or competitive terms which, say, the non-utilisation of Parent's work had on industry in the early part of the 18th century, we can make such appraisals for more recent examples and will turn to these next. What I particularly wish to emphasise is that lack of knowledge of the existence of a piece of information is only one factor in the picture and that many others are of at least equal importance.

The reasons why the best information and data are often not used have not changed and have been with us since the beginnings of our industrial society. What is changing dramatically as we move into the information based society is the scale of the associated economic, political and military penalties.

MODERN CASE HISTORIES

In focussing on specific examples of the various consequences of the use of inadequate information I shall classify the costs under three broad headings - Capital Costs, Manufacturing Costs and Operating Costs. "Costs" is used in a broad sense and covers financial, manpower, time and other disruptive losses.

Capital Costs

The conventional way of underlining the costs of lack of, or mis-use of, information is to evaluate the costs of programme delays due to re-working or of replacement of capital equipment. In a 1971 NASA report the costs of failures relating to fractures totalling some $1.8 billion were reviewed. They included:-

F-111, use of flaw sensitive steel - delays and costs of $150-$190 Million
NASA 260 Inch Motor, improper welding processes - loss of $17 Million
NASA SPS Tank, machining marks and aggressive environment - loss of $10 Million
NASA LM Tanks, stress corrosion, inadequate welding techniques - costs of $4.7 Million
Military Aircraft losses, 1962-1970, structural failures - losses and costs of correction $1 Billion.

It is not identified that all of these failures can be associated uniquely with a mis-use or ignorance of available information. But in many instances it was a factor. Specifically, reference (7) reports that the NASA 260 Inch Motor was fabricated from a relatively new material, that data existed in the Aerospace Structural Metals Handbook and that the welding procedures which had been used were identified as unsuitable in that handbook. Cases in which data were available, provided to all responsible parties but not used, or improperly applied, with consequences of serious failure were not new even in 1971. Eight years earlier, in a talk on the NASA Space Vehicle

Design Criteria Program, given to the Aerospace Research and Testing Committee of AIA in September 1963, R.V. Rhode records precisely such a case in relation to a structural design problem which led to an early space vehicle failure. (Ref. (8) appends an extract from this talk which, I believe, is otherwise unpublished).

It should not be thought from the foregoing examples that NASA in particular, and the USA in general, are alone in suffering the consequences of non-use or mis-application of available information. Nor are the aerospace and other high technology industries alone in being able to estimate the capital cost escalations of inadequate information and data. David Roth of Allied Corporation points out, (9), that in the chemical and related industries underdesign leads to costly refits. So a design engineer faced with questionable data adds an overdesign safety factor. The consequences of doing so are to escalate capital costs. In the extreme a sound investment opportunity may thus be abandoned in pre-project analysis. The availability of precise data and prediction tools (which may well already exist though not in a suitable form or with sufficient visibility) could, Roth estimates, reduce annual capital and operating costs in the chemical and related industries by some 5 percent. This represents an annual saving of over $7 Billion.

Fracture and corrosion of plant and equipment represent a drain on the owner's capital assets which is only partly attributable as an operating cost depending upon the rate at which the plant or equipment is employed. In analysing studies of these costs, undertaken by the National Bureau of Standards and by Battelle, Rumble (10) demonstrates that annual savings of as high as 23% in the case of fracture and 15% in the case of corrosion, together representing a value of $49 Billion, could be recovered simply by using "best current practices". An important part of this recovery is seen by Rumble to require the improved dissemination of existing data.

The ultimate demonstration of the capital costs of not having, or not using, the best information available would occur if the total assets of a company were overwhelmed by a judgement against that company in a consequent liability suit. Unfortunately from the point of view of my present thesis, though fortunately from the point of view of those who would have suffered in such a catastrophe, I know of no case - yet - in which there is clear and unequivocal evidence to that effect. Indeed, there are numerous reasons why such a case may never come to record, as I have discussed elsewhere (11). Even if we had evidence of such a dramatic case I am in some doubt as to whether it would really induce a wider appreciation of the value of information. We none of us respond willingly to an approach which is basically negative, 'the stick' as distinct from 'the carrot'.

In contrast let me conclude this section of my paper with a quite different example, more positive in its nature and, in my experience, more positive in its effect on the listener.

In the early 1970's a public utility in the UK had need to design and build a series of lattice structure towers. They were using a long established code as a basis to estimate wind loadings on the structure. After designing and building several such towers the engineers involved suffered "the gut feeling" that the wind loading estimates may be wrong and, subsequently, wind tunnel testing indicated that their estimates were probably some 30% too high. At about the time this was revealed my own organisation had just completed preparing a set of evaluated wind loading information, a more widely based and highly refined set of data than had previously been available. These confirmed the wind tunnel testing and provided a confident basis for the design of the towers. But more than this, they enabled a cost reduction on the original tower building programme of nearly £0.5 Million in materials costs alone.

It is rarely possible to demonstrate in such positive terms capital cost savings in development projects. It comes as near as any example I know to the ideal of being able to demonstrate the positive effect of quality information on a company's Return on Managed Assets. However, there is a postscript to this incident. Some time afterwards a colleague was telephoned by an engineer from an off-shore plant company who explained that he had a need to estimate the wind loading on a lattice structure and needed reliable information urgently. Perhaps with the objective of persuading my colleague to see him he remarked that money was no object to the off-shore industry when it needed to solve a problem of this sort. A meeting took place and my colleague was able to identify the set of data which did exactly what was required; but it was never obtained by the company because, it seems, the cost of the information, about £100, was seen to be unrealistic for a solution which already existed in the form of a few sheets of printed paper. This is not the only example to my experience of what I call the "Pied Piper syndrome" - the solution to a problem is valued much more highly when it is sought than when it is known to be already available!

I have dwelt on examples of the capital cost consequences of not having refined information at some length. Demonstration of initial cost savings in plant and hardware should have more impact than considerations of operating cost savings, particularly in the military procurement environment. It is more attractive for a procurement official, and thereby for the vendor of a piece of strategic hardware, to be able to show savings in first costs than to show savings such as those attendant upon the operation, maintenance and rejuvenation of hardware; these may not

be evident in service until many years after the procurer and vendor have retired! Human factors of this sort can be remarkably important when choosing the ground on which to demonstrate cost benefits in any field.

Manufacturing Costs

The costs of manufacturing play an important part in the capital cost of a project though the balance between manufacturing costs, material costs and information costs is starting to shift from its 'industrial era' relationship as the robotic, computational and the other techniques of the 'information' or 'service based' society start to take effect.

For example the decision as to whether a machined part, containing a stress raiser such as a fillet radius, needs grinding or other treatment after turning in order to achieve a pre-determined fracture resistant performance, depends heavily on the data available on stress concentration effects and on the fatigue performance of the chosen material as a function of its surface finish. Reliable cost information on the machine tool inventory is also required. These data are frequently available though confidence in their use at the design stage is heavily influenced by their non-linear interactions and sensitivity to small changes. Where data of sufficient quality in these respects is available confidence in their application can be ensured and manufacturing costs savings can be obtained (12).

There have been significant developments over recent years in the way in which research data and expert knowledge can be presented via the computer. They offer some prospect of demonstrating the value of reasonably complete information in financial terms and even for this to become self evident. In the process of choosing between alternative component geometries, machining processes and materials, considerable time is needed by traditional desk methods to select optima; they can generally only be found by working through many alternatives. Regularly up-dated information on a wide range of processes, based on high quality evaluated data and expert knowledge in the form of micro-hosted databases, (13, 14, 15), enables the decision maker to try out quickly and cheaply a number of alternatives on many of which he or she might otherwise have no knowledge.

The cost consequences are immediately apparent. To make the point of the value of information and data in this form an exercise could be conducted simply by comparing the manufacturing/materials costs of a recently completed design, based on the limited database available in the company, with the cost of the optimum solution revealed by quickly working through a large number of alternatives with the micro-hosted database.

Manufacturing costs are a sub-set of capital costs. But that aspect of manufacturing which relates to the choice of materials can also affect operational costs.

Operational Costs

Managements often seem willing to sustain unnecessarily high operating costs with less concern than that with which they contemplate unnecessarily high capital or manufacturing costs; I have speculated on why this may be so earlier in this paper. Very often, of course, the fact that operational costs are higher than they need be (for whatever reason) does not become apparent even when they involve substantial sums of money. Design or R&D inadequacies often are not catastrophic and it is surprising just what the operators of plant will accept as normal even though their revenues and company profits are steadily being eaten away. Some years ago a single stream chemical plant in the UK was subjected to occasional stoppages due to repeated failure in a shaft which was part of a pump in auxilliary equipment. Each stoppage involved a relatively small loss of production though in absolute terms it was valued at some £100,000 for each day taken to effect repairs. The losses continued for some time and appear to have been accepted as inevitable. Eventually an engineer identified that the basic cause of failure was the incorrect evaluation of a stress concentration effect. Better data, which had in fact been available for some time, was applied in a re-design and no further losses were experienced. I have previously discussed this case in reference (11) where also will be found an example, though without quantification, of the extent to which designers of aircraft were at one time blissfully unaware of the assumptions they were making concerning the accuracy of their drag data. It came to light that, in some cases, they were assuming values nearly 3% better than could be substantiated by their research colleagues who provided the basic data on which they were working. This was having a corresponding effect on the fuel and operating cost of the vehicles they were designing.

Again, the difficulty is that no two projects ever differ only in some aspect of data or information such that it may be isolated and its effects positively demonstrated. Some years ago we undertook an exercise to reconstruct at least part of these conditions by a rather indirect route. Though I have reported the results on a number of occasions I shall repeat them again because they suggest a new exercise which, I believe, would have particular relevance to our NATO community under present day conditions.

We specified a simple component, a shear web with a flanged lightening hole, of known size, material etc. Then we used the data in use by five different companies to estimate the strength of that component. The component and the relative strengths estimated from each company's data are shown in Figure 2. Such components were, and are, extensively employed in the structures of transport and other aircraft of all sizes. None of the aircraft designed by any of the companies whose data had been used had suffered failure in these components. So, in order to meet its design loads, Company E would have been using a material approximately 50% thicker than that being used by Company C, or than was really needed. The effect of this difference, in terms of revenue potential for a hypothetical fleet of 10 medium sized transports, is dramatised in Figure 3. These differences never came to light in reality, of course, because no two of the five companies ever produced aircraft identical except in this one feature; but many of the aircraft being designed on the basis of these data were undoubtedly producing lower revenues or suffering higher operating costs than were necessary.

I have previously used this example to illustrate the cost benefits of using good data. But there is now a further point which has to be made. Large military and civil projects are increasingly being undertaken on a collaborative basis. There are currently many examples of such collaboration between companies in the NATO nations where design of a large or complex vehicle may be distributed between several companies. The potential for disruption attendant upon the use of different data and information resources by the collaborating partners, quite apart from the off-optimum designs which could result, can not be in the interests of the Alliance or of its constituent parts.

To bring the point home more generally, and particularly to promote awareness of the value of high quality information resources of all types, I would suggest the following. Several groups, such as AGARD's technical Panels, might be invited to select one or two phenomena in their fields of interest, along the lines of the foregoing example, and to specify the necessary conditions surrounding particular cases. They might require, say, the drag coefficient of a particular type of flap under given flow conditions, the strength of a specified type of composite panel under a defined loading, and so on. Companies and laboratories would then be invited to report the values they would use for these data. Subsequent reporting (in anonymous form) together with estimates of the cost consequences would have two effects. First it would provide a dramatic demonstration of the costs contingent on the variable quality of the information actually in use by the establishments concerned. Secondly, it would provide forewarning of the disruptions which might affect those involved in technical collaboration. A third and important effect would undoubtedly be that each establishment, able to recognise in the final compilation only its own data, would have cause to pay better attention to the information resources on which it was relying. This need not be either an expensive nor a time consuming exercise. The examples chosen need to be carefully specified but the fewer the number of possible variables involved the better so as to more clearly illuminate the disparate nature of the information which many of us undoubtedly are using.

CONCLUSION

Scientific and technical information is an integral part of research and development programmes and always has been. In discussing this integration nearly 25 years ago (16) in relation to what was fashionably called 'the information problem', it was observed that examination was needed not only of the information traffic itself but of the attitudes and procedures of the sources generating that traffic and among those who should benefit by it. There was then a commonly held belief, among information specialists, that the value of the information available was not realised because those who should be using it were either not aware of its existence or, where they were, did not value it sufficiently highly to ensure its proper storage and retrieval. The consequences of relevant existing information being unknown, or not being readily available, are certainly important factors to dwell upon when we seek to establish the value of information systems to the economic and military well-being of the modern industrial community. But these are not the only factors.

We must appreciate that those in command of our industrial enterprises may never place the importance we might like them to place on the ready availability of scientific and technical information; other types of information figure more immediately in their scale of priorities. In any case, the ready availability of scientific and technical information does not ensure that the value of that information will be realised. It may still be erroneous, incomplete, or in a form not suitable for application. Or it may just be ignored, for a whole range of human reasons. Even when these obstacles can be overcome, the value placed on existing information is an order less than that placed on information which is thought not to exist - this I have described as the Pied Piper syndrome.

For these and other reasons, demonstrations of the cost and other consequences of not having or of misapplying information seem to have little effect. Even though we have a few examples which come close to demonstrating positive cost benefits, completely convincing evidence of such benefits may not be attainable.

The collection of evidence of the costs of not having refined information and attempts to demonstrate positive cost benefits are to be applauded for it is necessary to spread awareness of these matters. Even so, I believe the time has come to try other routes to establish that the information element is indivisible from any activity which affects our economic or military well-being.

Two rather different exercises have been proposed which would relate cost consequences to the quality of information which is actually in use. They would not only demonstrate the value of high quality information but do so in close proximity to current research or development programmes.

First, soundly based, micro-hosted databases can now be used to demonstrate benefits in terms of materials cost savings or manufacturing costs savings for projects currently in hand. Alternatively, they could be used experimentally to demonstrate the effects of less adequate databases by running design examples once with the complete database and again with part of the database arbitrarily or selectively removed. Selective degrading of the database might be on the basis of removing all data from one or more foreign countries, or on the basis of removing all data relating to a certain time period.

Secondly, the variation in the data actually in use relating to well defined phenomena, such as described in the previous section, could be revealed with the assistance of expert groups such as the AGARD Panels. This exercise would have several effects. It would indicate to each participating establishment how it stood in relation to its competitors and this, as seems to be established, is a matter of some consequence to decision makers in our command structure. Beyond this, however, the exercise would also clearly demonstrate to those about to embark on collaborative programmes the work that needs to be done on their information resources if disruption and consequential expense are to be avoided.

There is a need for demonstrations more dynamic than those which can be given simply by illuminating the historical costs of not having refined information. They are needed so as to help us ensure that more than lip service will be paid to the value of information as an integral part of our aerospace and defence programmes.

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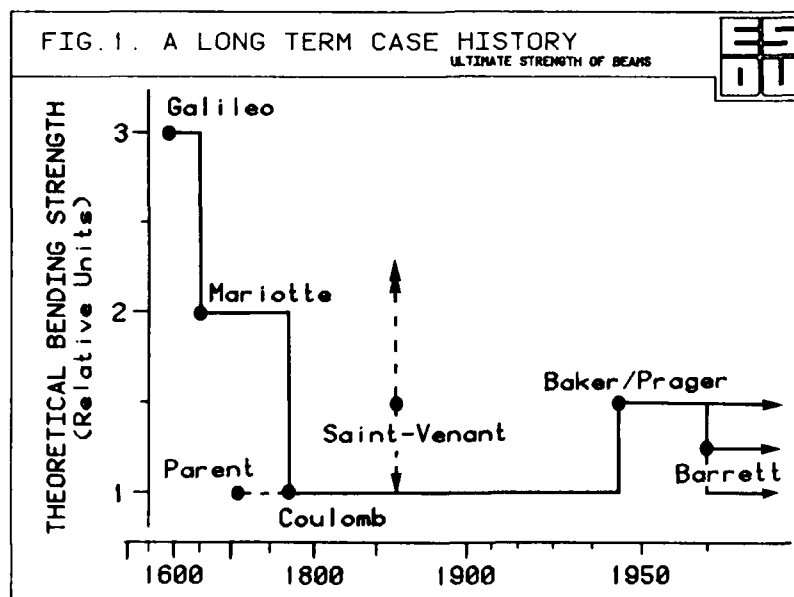
FIGURES

FIG.1. A LONG TERM CASE HISTORY
ULTIMATE STRENGTH OF BEAMS

FIG.2. VARIABILITY OF DESIGN DATA
DATA IN USE

Estimate by:	Buckling strength in shear:
Company A	0·79 X
Company B	1·07 X
Company C	1·63 X
Company D	0·94 X
Company E	0·72 X
Solid, simply supported plate theory	X

Sheet metal component

FIG.3. VARIABILITY OF DESIGN DATA
COST CONSEQUENCES

10 'plane fleet using lightest

10 'plane fleet using heaviest

ANNUAL FLEET REVENUE ACCOUNT

TOTAL $X

ANNUAL FLEET REVENUE ACCOUNT

TOTAL $Y

$X−$Y = $100,000 per annum

MEASURING THE VALUE OF INFORMATION AND
INFORMATION SYSTEMS, SERVICES AND PRODUCTS

by

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Abstract

This paper presents an approach for measuring the value of information and information systems, services and products. It also discusses results of four research projects that have measured value of recorded information used by professionals such as scientists, engineers, managers, etc. Furthermore, data are given on the value of such systems and services as a bibliographic database of international publications, online search systems and libraries. The approach used to measure value includes several perspectives. The first perspective is what users are willing to pay for information in terms of money (if exchanged) and the price paid by users in terms of their time and effort to get and read the information. Once information is read and assimilated, there are many purposes for which it might be used such as in one's work, to educate oneself or others, to satisfy one's curiosity, etc. The consequential value resulting from information use is partially measured by the savings that are derived from information use. Higher order values are how the consequential value affects the user's organization and, in turn, society.

BACKGROUND

Governments spend billions of dollars each year on research and development. The return on this investment is initially achieved through the accomplishment of specific goals and objectives of the R&D and through knowledge that is directly obtained from research results. However, perhaps far greater return on the investment comes from the research information obtained and used by others. Several studies by King Research [1,2,3,4,5] in recent years have clearly demonstrated that information derived from federally-funded R&D is extensively read and used by scientists and engineers. Readings of such information are used for many purposes such as research, professional development, education of others, writing, proposal development and management. Each such purpose has some value, otherwise scientists and engineers would not devote their scarce time to getting, reading and using information. One source of value of information is in cost avoidance such as not having to repeat research in which results are already available. In the literature and through ones own experience, there are many anecdotal data concerning such savings. The

studies mentioned in this paper have attempted to estimate the total extent of such savings by observing accounts of savings from a random sample of scientists and determining the consequences of their readings of articles and technical reports. All readings in 1984 of articles and technical reports are estimated to yield total savings in the order of magnitude of $300 billion. This amount seems enormous, however, if all scientists and engineers were denied access to all such information, it is doubtful that they could possibly accomplish their work. Looked at in this way, perhaps the $300 billion is a conservative estimate.

Another way to emphasize the importance of reading and keeping up with current research findings is to consider the rapid growth of science and technology. The amount of recorded literature doubles about every 15 to 17 years. This means that all the scientific knowledge recorded throughout the history of mankind up to 1970 has now doubled since that time and probably will double again by the end of this century. This means that a scientist, when he graduates from college, will be exposed to only one-sixth of the knowledge that he must master during his career. This doubling of the literature also means that information professionals must provide access to twice as much material now as they did in 1970.

Because of the necessity to keep up with the literature, scientists, engineers and other professionals read an enormous amount of articles, technical reports and books. Our research shows that all professionals in the U.S. such as scientists, engineers, medical practitioners, lawyers, educators and businessmen read over one billion journal articles a year and scientists and engineers account for nearly one-third that amount. They average reading* 110 journal articles, 78 technical reports, and 12 books each year. Well over 500 million hours are expended each year by scientists and engineers reading these materials. This time is testimony to their assessment of the value of the information they read; otherwise, they simply would not take the time to get and read the information because their time is such a scarce resource. This time spent reading come to over $20 billion in the U.S. and, when considered with the resultant $300 billion found in savings, there is little doubt about the value of information and the return on the investment in the research which is reported in the literature. A more interesting question in some ways is what contribution information systems, services and products make to the value of

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*By reading is meant going beyond the title and abstract to the text of the article, etc.

information. Clearly, without these there would be very little reading of research results and, therefore, a substantial loss in value.

There are two basic steps used to measure value of information systems, services and products. The first step involves measuring (1) willingness-to-pay value and (2) consequential value in terms of savings that directly result from the use if information derived from services such as those provided by a library. This is done by estimating the amount of use of information and its value. The second step is to determine how much use (hence value) is attributable to the service(s) by estimating the cost and use of the least expensive alternatives to the service(s) and comparing the cost and performance to the service. For a given budget, one can estimate number of readings and amount of use and value that would be lost if the alternatives were used. The amount of uses and value lost due to the service not being available is considered to be the value of the service. In this paper, examples are given for the estimate value of the services provided by the Department of Energy and Department of Defense technical information centers and of libraries that serve scientists funded by DOE.

THE VALUE OF TECHNICAL INFORMATION CENTERS

It is clear that information products and services can substantially help achieve a large return on R&D investment through providing better information and increasing use of information. Factors related to increased value of information are depicted in Figure 1. As shown, better information can be achieved through such processes as refereeing and editing materials, supporting compilations and analyses of information, and so on. Use of information can be increased through higher quality of information, better performance (e.g., rapid response to requests for copies of technical reports), lower prices (which increase purchases or acquisition), and increased awareness of technical reports and journal articles through use of secondary products and services such as printed bibliographies and on-line bibliographic services. These improvements in turn lead to increased value to readers, their organizations and funders, and ultimately to society.

The technical information services program managed by the technical information centers of the Departments of Energy and Defense are programs which have responsibility of managing the information products from the multibillion dollar R&D programs and maximizing their use of staff and contractros. For example, they help increase use of technical reports by

6-4

R & D

Primary Information → Secondary Information

Development of Primary Products & Services

Development of Secondary Products & Services

Lower Effective Price | Better Performance | Higher Quality | Greater Awareness

More Purchases/Acquisition of Secondary Products & Services (Quantities Demanded)

Increased Value to Searchers

Lower Effective Price | Better Performance | Higher Quality | Greater Awareness | More Use of Secondary Information

More Purchases/Acquisition of Primary Products & Services (Quantities Demanded)

Increased Value to Readers

More Use of Primary Information

Education (Self & Others) | Research | Management

Increased Value to Organizations / Funders

Greater Knowledge | Better Research/ Higher Productivity | Better Decisions

Use of Greater Knowledge | Achieve Mission of Organization | Achieve Mission of Organization

Increased Value to Society
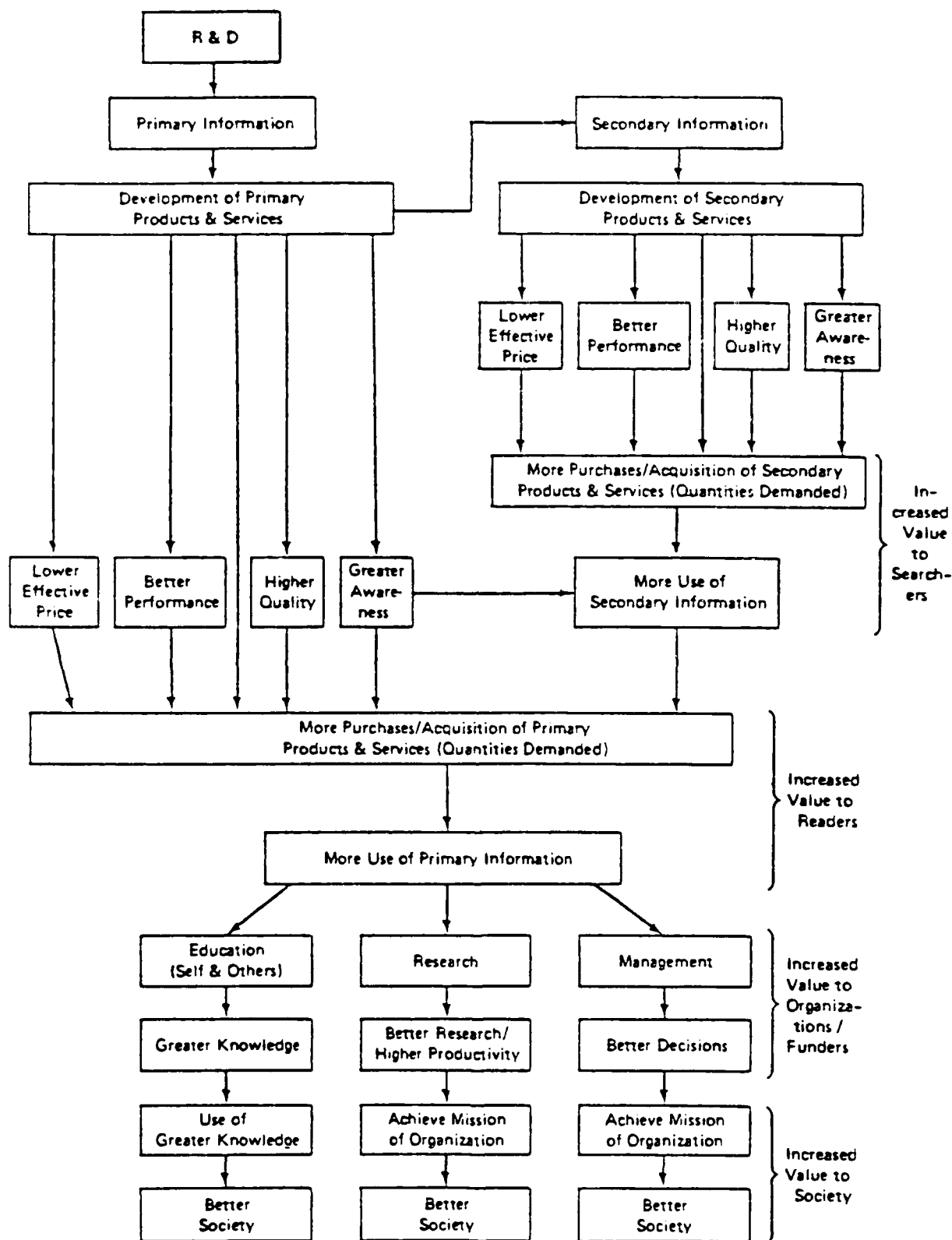
Better Society | Better Society | Better Society

Figure 1. Factors Related to Increasing Value of Information

Source: King Research, Inc.

making copies available in paper copy and in microform. The amount of reading by scientists and engineers funded by the two Departments is summarized in Table 1 below.

Table 1

Average Annual Number of Readings Per Scientist or Engineer
of Journal Articles, Techncial Reports and Other Materials
By Department of Energy, Department of Defense and
All U.S. Scientists or Engineers: 1982, 1984

Type of Material	Funded by DOE (1982)[3]	Funded by DOD (1984)[4]	All (1984)[2]
Journal Articles	118	152	110
Technical Reports	110	116	78
Books (and other materials)*	15	23*	12

The total amount of reading for about 60,000 scientists and engineers funded by DOE, 157,000 by DOD and 2.5 million overall in the U.S. (of which about 700,000 are engaged in R&D) is given in Table 2 below.

Table 2

Total Number of Readings and Total Amount of Time Spent
Reading by Type of Material and By Soruce of Funding: 1982, 1984

(Millions)

	Scientist and Engineer					
	Funded by DOE (1982)		Funded by DOD (1982)		All (1984)	
Type of Material	No. of Readings	No. of Hours	No. of Readings	No. of Hours	No. of Readings	No. of Hours
Journal Articles	7.1	7.1	23.9	20.0	275	247
Technical Reports	6.8	10.2	18.2	17.4	195	390

At current scientists' salaries, benefits and overhead ($28.44 per hour), the total expenditures of reading articles and technical reports comes to $297 million for DOE, $1.1 billion for DOD and $18 billion for all scientists and engineers.

The costs of getting and reading journal articles and technical reports include the following cost categories:

Journal Articles	Technical Reports
Purchase and Processing	Report Copy Purchase and Processing
Individual subscriptions Library subscriptions Reprints/prescripts/ILL Other	NTIS paperform NTIS microform Other
Identification	Identification
Manual search Online search Other Combined	Manual search Online search Other Combined
Access Reading	Access Reading

Typical costs at current levels come to about $45 per journal article read. The proportion attributable to various activities being: purchasing and processing (18%), identification (11%), access (7%) and reading (64%). Similar results for technical reports is about $55 per reading: purchasing and processing (8%), identification (4%), access (11%) and reading (77%). These numbers, of course, vary by the sources of funding from the different Departments and across all scientists and engineers.

Value of information is computed at two levels: (1) what users are willing to pay for information in terms of monies exchanged and in their time and effort getting and reading the information and (2) the consequences of reading in terms of savings to the users in labor and equipment. The former value is computed by multiplying readings by the appropriate article and technical report reading costs as calculated above. The value in terms of savings is found by multiplying observed average savings which was found in the surveys. An example of savings observed in the survey was: a nuclear scientist reported savings of about $1,000 from reading a

technical report on steam electric plant construction costs and production expenses and thus indicated he did not have to repeat the report's calculations. It is noted that the average values are from highly skewed distributions of savings in that only 25 percent of the article readings resulted in savings and 75 percent of the technical report readings did. Some very large savings (i.e., outliers) were not included in the calculations. The values in savings estimated in this way are as follows:

	Readings	
	Articles	Technical Reports
1) Department of Energy	$590	$1,280
2) Department of Defense	—	$4,700

The total value in terms of willingness to pay and savings to the users is summarized below.

	Willingness-to-pay		Savings to Users	
	DOE	DOD	DOE	DOD
Total Value of Information Read	$530 mil	$564 mil	$13 bil	$58 bil

Not all readings result, however, from DOE and DOD systems, services and products. If only these readings are included, the value is as follows:

	Willingness-to-pay		Savings to Users	
	DOE	DOD	DOE	DOD
Total Value of Information Read	$500 mil	$560 mil	$13 bil	$58 bil
Total Value Directly Attributable to DOE and DOD Services	$240 mil	$380 mil	$ 8 bil	$38 bil

Another approach to assessing the value of the databases is to consider what would occur in their absence. Scientists and engineers can search or identify information by means other than the database products and services. For example, chemically related journal articles can be found in the Chemical Abstract Service's products; nuclear secondary information can be found in INSPEC products, etc. It generally costs more to do so, and searching of several databases may be required to achieve comparable results. In addition, some items are covered only in the databases. If the databases (or specific database products or services) were dropped, some substitute means of searching would be adopted. This means that either costs to the searchers would be higher or, under fixed budgets, there would be fewer searches performed with consequences of correspondingly fewer readings aad less savings from the readings.

The way in which we calculate the consequential values of database products and services was to determine the direct effects of the searches that would be lost by substituting other products and services and assuming a fixed total budget. There are three types of secondary products and services that use the database information: online searching, in-house developed printed indexes, and other printed indexes; other on-line services such as Lockheed Dialog and others that have the NTIS data base (which includes many database items); and BRS which provides access to one database. By dropping all these products and services and substituting others, there would be many fewer searches and therefore even fewer readings. For DOE, this results in the reduction of willingness-to-pay value $90 million, and the value of savings in time and equipment by $3 billion.

The latter figure, $3 billion savings in labor and equipment from the energy products and services, can be roughly translated into productivity. If it is assumed that, with the energy database, research and development costs $5.8 billion for a given level of output, without the database the same output would require an investment of $8.8 billion. This is an increase in productivity of about 52 percent. This says that to accomplish the same R&D output without the information services, the R&D budget would have had to have been $3 billion higher.

In summary, the value of information and information systems, services and products of the technical information centers of DOE and DOD are as follows:

	Willingness-to-pay		Savings to Users	
	DOE	DOD	DOE	DOD
Total Value of Information Read	$500 mil	$560 mil	$13 bil	$58 bil
Total Value Directly Attributable to DOE and DOD Services	$240 mil	$380 mil	$ 8 bil	$38 bil
Value Added by the DOE and DOD Services	$ 90 mil	$240 mil	$ 3 bil	$ 9 bil

Thus, the total value of the services of both Departments is estimated to be $330 million in what users are willing to pay and $12 billion in savings to the user.

VALUE OF LIBRARY SERVICES

A similar approach was used to estimate the value of libraries. This was done by studying these libraries that are funded by the Department of Energy. There are approximately 5,200 professionals who work at the three libraries: Rocky Flats, Rockwell Energy Systems Group and Oak Ridge National Laboratories (ORNL). The professional staff of Rocky Flats, Rockwell and ORNL clearly read a great deal even though not all professionals surveyed are scientists and engineers engaged in R&D. Table 3 gives the average and total number of readings of journal articles, technical reports and books by these professionals.

Table 3

Number of Readings of Journal Articles, Technical Reports and Books
by Professionals at Rockwell, Rocky Flats and ORNL - 1983/84

	Journal Article Readings*	Technical Report Readings*	Book Readings*
Average Annual Readings	99	44	15
Total Readings at 3 Sites**	514,000	228,000	78,000

*Readings are defined as going beyond the contents, title and abstract to the body of the article, technical report or book.

**Based on an estimate of 5,188 professionals found at the three sites.

SOURCE: King Research, Inc. - General Usage Survey (n=137)

It is estimated that the energy professionals in the survey spend an average of 0.9 hours reading an article, 1.5 hours reading a technical report and 4.4 hours reading a book. This corresponds closely with the findings from the general NSF survey of scientists and engineers performed by us for the National Science Foundation [2]. Professionals' time is a scarce resource and they allocate their time to reflect how they can get the most return for their time invested. Again, the fact that the energy professionals spend about 233 hours a year reading articles, technical reports and books indicates that they consider the information read to be of significant value to them. In fact, their time spent reading is considered a component of what professionals are willing to pay for information. It is estimated that the average cost of reading per professional is $6,400 per year. The amount of time spent reading is summarized in Table 4. The total cost of time spent reading at the three locations is estimated to be about $33 million.

Table 4

Amount of Time Spent Reading and Cost of Reading Journal
Articles, Technical Reports and Books Read by
Professionals at Rockwell, Rocky Flats and ORNL - 1983/84

	Journal Article Reading	Technical Report Reading	Book Reading	All Reading
Average Annual Time Spent Reading	95 hours	75 hours	63 hours	233 hours
Average Cost of Time Spent Reading	$2,600	$2,100	$1,700	$6,400
Total Cost of Time Spent Reading	$13.5 million	$10.9 million	$8.8 million	$33.3 million

SOURCE: King Research, Inc. - General Usage Survey (n=137)

Obviously, since energy professionals spend so much time reading and for many useful purposes, they must be willing to pay an appropriate amount for the information. The price they are willing to pay in addition to money paid for subscriptions, etc., includes their personal time and effort expended to identify, gain access to and read the articles and technical reports. We have estimated this time and cost associated with readings of library materials. In addition, we asked the professionals to indicate what they would be willing to spend to obtain the article (or

technical report), not including their investment of time. This price, which corresponds to consumer surplus in economic terms, is estimated to be $6 per article reading and $56 per technical report reading. The estimates of how much users are willing to pay are given in Table 5.

The average values in terms of willingness to pay are estimated to be about $36 for reading a journal article and about $102 for reading a technical report. Applying these estimates of value (e.g., willingness to pay) we arrive at a total of over $42 million. It is noted that these estimates of value of information include only the cost (or price) borne by the users. They do not include such library costs as purchase of subscriptions, searches performed by reference librarians, etc. The calculations of the average value per reading are subdivided by the appropriate methods of identification of materials read. These methods included: by accident while browsing through the library materials, from another person (i.e., a colleague), cited in an article or other publication, cited in a printed index, cited in the output of a computerized literature search, routed by the library, from a library accessions list and other (e.g., article sent by an author for review). Obviously, the time spent by the energy professionals for these methods varied substantially and therefore, was reflected in the estimates.

The second level of value is measured in terms of the consequences that reading and using the information has on research, education and management. A portion of this higher order effect is estimated by asking the energy professionals to indicate if reading a specific recent article or technical report saved them or their co-workers any time on a current task or project. If yes, they were asked to estimate the approximate dollar value of the time saved. They were also asked if there were dollar savings for other things such as equipment and supply costs. Finally, they were asked to indicate the number of co-workers involved in the savings and how many of them also read the article or technical report. The indication of how many read the article or technical report was determined in order to adjust the estimates of total savings. For example, if two energy professionals on a project read an article, they both would have presumably achieved and reported the savings. Thus, the reported savings are halved.

Table 5

Value of Information in Terms of What Users
Are Willing to Pay - 1983/84

Source of "Willingness" Value	"Willingness" Value Per Reading ($)	Total "Willingness" Value ($)
Journal Readings		
Identification	$ 2.26	$ 1.2 million
Access	3.41	1.8
Reading	24.64	12.7
Additional Value	6.00	3.1
Total	$ 36.31	$18.8 million
Tech. Rpt. Readings		
Identification	$ 1.72	$ 0.4 million
Access	3.65	0.8
Reading	41.07	9.4
Additional Value	56.00	12.8
Total	$ 102.44	$23.4 million

SOURCE: King Research, Inc. - General Usage Survey (n=137)

The average savings found by reading journal articles is $385 and the average savings found by reading technical reports is $706. Applying these average values to the amount of reading yields a total estimate of about $360 million value in terms of savings.

The libraries (Rocky Flats Technical Library, Rockwell Energy Systems Group Library and ORNL Library System) are extensively used. In fact, the energy professionals at these locations are estimated to use the libraries (or their services) an average of nearly 25 times per year. In terms of the reading of journal articles, technical reports and books, it is found that a substantial proportion of readings came from library copies (see Table 6). In fact, the estimated average annual amount is 53 article readings per professional, 17 technical report readings per professional and 6 book readings per professional.

Table 6

Amount of Readings From Library Copies of Journal Articles, Technical
Reports and Books: Rocky Flats Technical Library, Rockwell
Energy Systems Group Library and ORNL Library System - 1983/84

	Proportion of All Readings	Average Annual Number of Readings/ Professional	Total Annual Number of Readings
Journal Articles	53%	53	275,000
Technical Reports	39	17	88,000
Books	40	6	31,000

SOURCE: King Research, Inc. - General Usage Survey (n=137)

There are estimated to be approximately 211,000 readings of journal articles and 87,000 readings of technical reports provided by the three libraries. The corresponding values of these readings calculated in terms of what users are willing to pay and in savings to the users are given in Table 7 below.

Table 7

Willingness-to-Pay Value and Savings Value
Directly Attributable to Reading Library Journals and
Technical Reports - 1983/84

($ million)

Source of Value	Willingness-to-Pay Value	Savings Value
Journal Readings	$ 7.7 million	$ 82 million
Technical Report Readings	$ 8.9 million	$ 62 million
Total	$16.6 million	$ 144 million

SOURCE: King Research, Inc.

These, of course, are not the values that are found by substitutions to the use of library materials. Under normal circumstances, the users could get these materials from other sources. Thus, the values are

determined by estimating the cost of using substitute sources for the information and determining the number of readings that would be lost if the total expenditure levels were maintained. The values of the lost readings are what we consider to be the values of the libraries. These values are given in Table 8.

Table 8

Willingness-to-Pay Value and Savings Value Found by Substituting for the Libraries: Rocky Flats Technical Library, Rockwell Energy Systems Group Library and ORNL Library System - 1983/84

($ million)

Source of Value	Number of Lost Readings	Willingness-to-Pay Value	Savings Value
Journal Readings	47,600	$ 1.7 million	$18 million
Technical Report Readings	13,600	$ 1.4 million	$10 million
Total	298,827	$ 3.1 million	$28 million

SOURCE: King Research, Inc.

Clearly, the two values are "soft" estimates, but they probably are in the right order of magnitude. Even so, the extent of number of readings from library materials, time spent by energy professionals in reading these materials and the value determined by what they are willing to pay suggests that library materials and services are extremely valuable.

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INTERNATIONAL INFORMATION EXCHANGE PROGRAMMES ARE NECESSARY
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SUMMARY

The economic and cultural ties between Canada, the U.S. and European nations are enhanced by various means of information exchange between and among countries. This paper will discuss the benefits of two different but interconnected processes of technology transfer: the alerting of allies to information available and the exchange of document literature.

Since concern about national security and proprietary information may preclude defence research and development programs from publishing, as do other disciplines, in the open literature, special exchange agreements are necessary. The programs which have existed for some years among various NATO countries usually limit the subject areas of common interest to be discussed, and the organizations to be included.

The paper will illustrate this process by describing the Canadian situation. Some of the existing Canadian exchange agreements will be examined, showing how they operate, the types of information which are included, the routes by which information is passed from one country to another. The ways in which information passes through the documentation centers to become a valuable service to the end users and thus enhance research and development productivity will be detailed. Specific examples of the use of international information exchange programs to some major defence projects will be shown. The release of information is beneficial to the releasing country as well as to the receiving country because of the increased visibility of the information and the resulting reciprocal transfer of related data.

All nations face some barriers to information exchange, such as the costs involved, the necessity for translations from one language to another, and the need to protect a country's interests with respect to technology transfer. These problems can be overcome, with the result that all parties to an international agreement can benefit from it significantly.

INTRODUCTION

As a member of NATO, Canada for many years has been a participant in many forms of international information exchange, with the US and European countries. This is a natural consequence of both geographical and historical factors. The location on the northern part of the North American continent, the combination of a large area to defend and a relatively small, highly dispersed population, and the sharing of industrial technology and markets, all lead to a close contact and 'good neighbour' policy with the United States. The British and French led the way in the exploration and settlement which led to the formation of a new country out of a vast wilderness. Settlers from other European countries followed, and all have made some significant contributions to Canadian culture. The formation of NATO after the second World War is a reflection of these economic, political and cultural relationships which already existed. The exchange of defence information is a major facet of NATO's programme.

The defence departments of all NATO countries are involved in some research and development projects which result in the preparation of scientific and technical papers. For reasons of security, or proprietary interests, or simply because the subject matter is not of general interest, only a portion of this work is published in open literature such as scientific journals. However, even if it is not published in the usual sense of the word, there is a requirement to disseminate research results to others who are involved in similar or related projects.

The NATO countries are also involved in projects relating to the interoperability of equipment, or the sale of supplies from one country to another, and for these reasons it is necessary to exchange information such as engineering data, drawings, equipment specifications, system manuals, operational plans and financial data.

INFORMATION TRANSFER

The international exchange of information is by no means a simple and straightforward process, and is highly dependent on the nature of the information being passed. There are two fundamentally different mechanisms of information transfer. Although it is an over-simplification, one can be considered as 'unlimited', the other as 'limited'.

When a researcher, or group of researchers has made some significant progress which is considered to be a contribution to human knowledge, it is usually written up as a paper for publication in a journal, or presentation at a conference attended by peers and colleagues. The purpose is to announce to a wide audience the fact that a discovery has been made, or to stimulate academic discussions and further research anywhere in the

world which will lead to more papers, and so on. Usually shortly after publication of research work, citations appear in data bases such as NTIS, Chemical Abstracts, and many others which are available internationally. In Canada, users have access to such data bases through the facilities of the Canadian Institute for Scientific and Technical Information, and also through other organizations. Another example of the unlimited exchange of information is the approach used by journalists, who report and comment on events as they happen. The point is that publication in an open forum removes all controls on the subsequent use of the information, and that situation is not reversible.

It is obvious that publication to a wide audience is not appropriate for 'military' information, or for any situation where there is a potential adversarial relationship between parties, and there is an advantage to be gained by withholding information from some people and disclosing it to others. For example, if during the course of a research contract, a company discloses proprietary information to the government for evaluation purposes, the government could not release that information publicly because any commercial advantage which the company might have would then be lost, but yet there may well be a need for the government to pass that data to another government. Sometimes there is a question of ownership of intellectual property, or of national security, which allows release of information only to personnel and organizations with appropriate clearances. In such cases it is necessary for the originator, who has some message to communicate, to distribute the information to a selected audience, on the basis of their need to know, or their ability to make use of the information in the performance of some specific task. The selection of the audience and the methods of distribution can be defined by the terms of an exchange agreement.

INFORMATION EXCHANGE PROGRAMMES

Although any effort to list all of the exchange agreements in operation, and their participants, would probably be incomplete, it may be useful to illustrate some of the types of agreements, and show the extent to which the department is involved.

A few years ago the Canadian Department of National Defence decided to evaluate its participation in international programmes, and found a variety of activities, which were then examined closely to inform departmental management about Canada's role. In addition to several programmes involving the U.S. and Commonwealth countries, and several bilateral programmes, Canada was participating in five different international programmes related to NATO:

        a.   NATO Research, Development and Production (NATO RDP);
        b.   Military Agency for Standardization (MAS);
        c.   Advisory Group for Aerospace Research and Development (AGARD);
        d.   NATO Communications Agencies (NATO Comm); and
        e.   NATO Integrated Communications System (NICS).

MEMORANDA OF UNDERSTANDING

Administration of international programmes is usually covered by a memorandum of understanding, which is an agreement, other than a contract, whereby the parties undertake committments concerning allocation of resources. It is a flexible instrument which defines terms and conditions under which cooperation will occur. It can cover a very specific subject or piece of equipment, or can be very general. There is no set of rules which describes how to write an agreement, and what data should be included, because each situation is different, and must be evaluated on its own merits. International cooperation takes a variety of forms and in many of them the exchange of research and development documents is a very important factor. Generally, any MOU includes identification of:

- the parties to the agreement and provision for adding other
interested parties

- the purpose, scope, and limitations of the cooperation to be
undertaken by the agreement

- the form or methods by which cooperation will take place
including types of information or assistance and services
to be rendered or acquired

- the means by which the rights and interests of the parties
will be protected including both security and proprietary
matters

- the means by which the cooperation will be managed and any
misunderstandings, disagreements, or disputes will be resolved

- the duration of cooperation and provisions for terminating it

- the limits on the commitment of resources.

Within the research and development branch, which is only a small portion of the department, there is a list of over a hundred and fifty MOUs, most of which are still active. The details of these agreements, and the associated correspondence, fills a filing cabinet.

STANDARDIZATION

Many international agreements deal with standardization, which is the process by which nations achieve the closest practicable cooperation among forces, the most efficient use of research, development and production resources, and agree to adopt on the broadest possible basis the use of:

    a. common or compatible operational, administrative and logistics procedures;

    b. common or compatible technical procedures and criteria;

    c. common, compatible or interchangeable supplies, components, weapons or equipment; and

    d. common or compatible tactical doctrine with corresponding organizational compatibility.

Standardization is generally a voluntary function which results in common usage, cross-servicing, interoperability and production of documentation. The development of an information exchange system which reports on the current status of research and development projects is an essential part of the function, and if it is 'non-public' information such as military technology, then the formation of a distribution network is also essential.

The standardization activities of NATO and other military groups usually are directed toward either engineering or operational standards. The engineering standards may require more management than operational standards because they are related to other standards and specifications which are part of the 'unlimited' technical literature. With the exception of some very specific types of equipment, military forces cannot have the luxury of their own engineering standards for standard equipment components, because industry will not operate to one set of standards for the military and one for everyone else. On the other hand, operational standards are related only to military procedures, and are not made public, so they are part of the 'limited' literature, which is distributed only under carefully controlled conditions.

For many years the NATO countries have used standardization agreements (STANAGS) to achieve some degree of interoperability and standardization. There are over one thousand active STANAGS covering a wide variety of subjects.

PERSONNEL EXCHANGE

Another very useful method of information transfer, which benefits all participants, is the exchange of scientists. Under the auspices of NATO, or some other agreement, a scientist from one country can be posted to another country for a year or two to work on some project in his area of expertise. The host country benefits from this by having immediate access to all the knowledge which the scientist brings to his position, and by the accomplishments on the project during the term of employment. The scientist broadens his knowledge by exposure to a different organization and by exchange of information with colleagues. Upon return to his home country, the scientist is in a position to disseminate any information which he has obtained as a result of the exchange, and thus his country benefits by increased access to information.

DOCUMENT HANDLING

In Canada, and probably in other countries, there are several routes by which technical and military information is passed in and out of the country. NATO documents, for example, all are handled by a central registry, which is part of the departmental records management system. From there, they are distributed to the members of various committees and panels, to those responsible for equipment, or to the scientific authorities. Scientific documents originating outside Canada are passed through the embassies to the Directorate of Scientific Information Services, which includes a record in a computerized data base and controls circulation according to conditions described on the document. DSIS also has announcement services which are intended to ensure that knowledge of the availability of reports is distributed to those people in the defence community who have the greatest interest in their content. Departmental correspondence with foreign embassies, exchange of documents and visits to other countries are all handled by the Foreign Liaison Office. Several directorates under the Director General International Programs are involved in activities related to procurement and sales of armaments and other equipment.

MAJOR EQUIPMENT ACQUISITION

As previously mentioned, a memorandum of understanding can be a very broad agreement, or 'umbrella', under which a variety of activities can take place, and in the case of a major equipment acquisition a very broad agreement would be necessary to cover all aspects of the transaction. A major piece of equipment such as an aircraft or ship has a large number of subsystems, e.g. electrical, structural, mechanical, communications, computers, radar, armaments, etc. Each of these in turn has a lot of components-circuits, materials, software, etc. with the result that the acquisition includes many separate transactions involving development, manufacturing and sales. During this procurement phase there is a lot of information flow in one direction and cash flow in the other. Later, during the implementation and operation phases, there is less cash flow, but the information flow continues, and begins to be more of an information exchange, as information is flowing in both directions. Also, during these later phases there is an

increased emphasis on standardization, as attention is focused on matters such as train-
ing, system testing, logistics support, operational tactics, repairs and maintenance.
At all stages of the procurement there may be personnel exchanges, at both management
and technical levels. For some major projects, the management of technical information
is considered so important that the project managers have set up their own technical
information centers, with full-time staff, in addition to making extensive use of the
central facilities already provided by the department.

BENEFITS AND COSTS TO PARTICIPANTS

It is important not only to understand what agreements are in existence, and the
details of how they operate, but also to examine the benefits to the participants, and
how these relate to the fundamental reasons for the existence of international infor-
mation exchange agreements. These reasons are related to the fact that no one country
by itself possesses all of the resources to provide adequate defence research and
development, and that by sharing resources, each country can then ensure that all have
access to the best technical information available. The President of the United States
and the Prime Minister of Great Britain stated this very well in 1957, in a Declaration
of Common Purpose, which included the following statement:

> 'The arrangements which the nations of the free world have made
> for collective defence and mutual help are based on the recogni-
> tion that the concept of national self-sufficiency is now out of
> date. The countries of the free world are inter-dependent and
> only in genuine partnership, by combining their resources and
> sharing tasks in many fields, can progress and safety be found.
> For our part we have agreed that our two countries will hence-
> forth act in accordance with this principle.'

Immediately afterwards, the Canadian government adopted the same position, and the
actions of the three governments eventually resulted in the formation of the TTCP
organization.

All information exchange programmes provide a means of acquainting each participant
with the programmes of each other participant, and an increased knowledge base. Each
national programme can be adjusted and planned in cognizance of the efforts of others,
unnecessary duplication can be avoided and if there are gaps in the collective technology
base, they can be filled more easily by a concerted effort than by several individual
efforts.

When an attempt is made to evaluate the effectiveness of the programmes, or the
benefits to the participants, it is found that there are both tangible and intangible
outputs. The tangible outputs in the case of standardization agreements are measurable
and quantifiable as engineering or material standards, or documents describing design
or production processes, or orders for commercial materials. There may also be standards
relating to operational, logistic or administrative procedures peculiar to military
forces. In the case of research agreements, the tangible outputs are usually scientific
reports and publications. In both cases, the results of the cooperative work become
visible to a wider audience than would be the case if the work were restricted to only
one country.

The intangible benefits are a little harder to describe, but they do exist and are
very important. For example, access to a body of knowledge which can be applied to the
solutions of operational problems, or to narrowing the choices in purchase of equipment
can lead to savings of time and money, although the amounts are difficult to quantify.
There is also the value of professional contacts with colleagues in other countries.
Participants in international programs have often expressed the view that face-to-face
contact at a meeting is much more beneficial than simply exchanging correspondence.
However, there are costs associated with travel, and management discretion is required
to achieve the correct balance of activities. There is also an opportunity to influ-
ence international opinion and improve military professionalism by exchange of views.
Information is a strange commodity because it can be exchanged or traded, with no loss
of its value. All participants in an information exchange programme have something to
gain, but they must be cautious about the unrestricted flow of information because it is
a form of technology transfer which may have unfortunate results if the need to know
principle is not correctly applied.

The exchange of information between two or more parties always requires some pro-
fessional judgement about how much detail is to be released, because there are many valid
reasons why some things, such as personal information, should be disseminated only under
controlled conditions.

It is possible to consider the economic aspects of information exchange, i.e. to
compare costs with benefits and thus reach some conclusions about the net value of the
programmes. There are costs associated with information production, with distribution
or publication, with operation of information systems, and with information retrieval,
On the other hand it is possible to estimate benefits in terms of time saved by not dup-
licating previous efforts, or money saved through standardization programmes, or other
benefits. In the specific case of international agreements, the costs associated with
travel and communications must be included in the analysis, and also the time and effort
necessary for translation from one language to another. If a true spirit of cooperation
exists among participants, the barriers to international information exchange can be

overcome, and also the cost-benefit analysis will show the value of the programme.

CONCLUSION

In conclusion the exchange of defence-related information in various forms has been considered important by the Canadian government for many years, and the policies and procedures which are already well-established can be expected to continue. It is important for all parties to information exchange agreements to realize that exchange is a two-way process, and that in order to receive useful information, it is also necessary to contribute as much as possible. The smaller countries may have less to offer than the larger ones, but everyone can contribute something, and all parties to an agreement can increase their knowledge as a result of information exchange.

THE IDEAL INFORMATION SYSTEM ? WHAT DOES THE USER REALLY WANT ?

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In planning future information systems, it is of an utmost importance
to take into account the user who finally decides on the success of the
systems. Sofar, system improvements have mainly been implemented with
the experienced user in mind. Therefore, if the information systems want
to get a better penetration, they will have to implement interfaces, fa-
ciliting thus the accessibility of the information by the non-experienced
user.
Also access to those "idealised" information systems could be improved
through better cooperation between telecommunication authorities.

From the Spring' 85 Cuadra Directory of online Databases (1), I would like to cite some figures :

	data bases & data banks	data base producers	online services
Spring '84	2225	1069	327
Fall '84	2453	1189	362
Spring '85	2764	1316	414

This gives us an increase over the last year of some 539 data bases and 87 host services,,which
means an addition to the directory of 2 data bases per working day. On a more "regional level",
the Euronet Diane Guide covers some 45 hosts offering around 540 databases. The Federal Data
Base Finder, a Directory of Free and Fee-Based Data Bases and Files available from the Federal
Government claims to describe 3.000 date bases.

Considering these figures one could wonder vhat users could expect more : through a terminal or
microcomputer, one has a whole world of information available at his fingertips, including a lot of
information sources he never had looked at before. Based on these considerations some very optimis-
tic forecasts on the use of on-line information services have been made in the seventies. In their
marketing effort hosts, quite evidently, also stress the point how easy it is to get some references
on any topic. However deception often comes after over-enthusiasm.

In order to find out some of the reasons why online searching, although still expanding at reasonable
figures, has not been able to meet the forecasts, it is perhaps useful to have a quick look at the
on-line scenario, in which we can distinguish four parties : the user, the data base producer, the
hostservices and the telecommunications.

The user plays a dual role in the information chain : he is at the same time the producer and the infor-
mation seeker. In this duality he may have conflicting interests. As provider he may help to keep up
the "information inflation" by producing f.e. two or three publications instead of one, or, for publi-
city reasons, by disseminating the same informations to different magazines or journals. As an user of
information he certainly will prefer a few, highly reliable references to some   hundreds of references,
of which a lot are redundant or are contributing only trivially to solve his problem. If multiple data
base searching is performed, the user faces another annoying fact : duplicate references for which he
has to pay extra royalties although they may seem very easy to eliminate.

Data base, producers define a scope they want to cover and consequently they have to draw up selection
criteria and an indexing policy and - rules.

It is very hard for them to incorporate a "value judgment" in their selection without hurting anyone
and I don't expect it to change the next years. Rules often are a burden on the indexers but the main
problem is the perception by the indexer and the user what the important points in an article are.
The indexer has a broad community of users to serve with whom he has no direct contact and therefore
no or very little feedback. As it is the intention to make the database accessible to the widest pos-
sible community of users the indexing systems or cataloging codes are intended to be as universal and
as general as possible. Maintenance of these indices are usually done by committees who try to obtain
the widest possible consensus on any changes. To attempt to enhance the indexing sheme for the needs
of each individual researches is, however, absolutely out of the question in the case of these large
publicly available data bases.

Some (2) argue "tnat the way in which a researcher organizes the subject matter of a field may be an
essential part of the creative process of scientific research. What is therefore needed is a system
to allow researchers to create and use their own indexing system." I don't know if everyone will agree
with this statement but in any case in order to feed the individual system, references have to be
extracted from an outside data base, not completely suited for the needs of the individual user with the
consequent selection problems.

Mentioning indexing and cataloging evokes another point of user concern : most data bases on the market to day are still mere spinn-offs of their printed equivalents with indexes designed for manual searching which is not necessary optimal for computer searching. Finally, pure economic imperatives can also have an influence.

Hosts make it possible for the user to have access to one or more data bases through a search software. Competion among the major hosts forces them continuously to improve their software, offering enhanced capabilites and to reload regularly the data bases to keep face with their "colleagues". This is all to the benefit of the user. However, I am afraid that not all these new developments are fully exploited by the unfrequent, unfamiliar user. The superindex of data bases (Dialindex, Crossfile, Questindex ...), the standardization of field codes across all data bases on a host and/or of certain fields as e.g. the author field are probably exceptions to the rule. But the zoom- or Get-like commands f.e. deserve more general attention.

Problems however start to build up when one has to switch from one host to another. I do recognise that it is useful to have access to various systems, to be able to choose. When one system is out of function, another may be used if a search is urgent. Different systems may offer the same databases, but there are sometimes differences in the way they can be searched. Search commands differ from one system to another, and various features are made searchable. A database can be split into sub-files in one system, while kept complete in others. Prices can vary between hosts, and computer responses may differ, which also affects the search costs. (3). I do not claim that there are as many search softwares as there are online services (414 as identified in the Cuadra directory) but hosts have the nice habit to make changes to a basic software package so that one gets a lot of variants. This only complicates life for the user, especially the unfrequent user, who also deplores a total absence of standardization accross hosts (field tags, command language ...).

I also have to mention the administrative problems associated with the signature of multiple contracts and the obligation of having to pay a lot of invoices in different currencies.

It therefore is quite easy to understand that most users are not willing to learn to work with more than 4 to 5 host systems.

The next partner in the information chain are the PTT's. They only have a carrier function which is almost transparent to the user except when one has to type in the NUI-NUA sequence or when one suddenly receives some funny message from the network. One normally would not expect a lot of problems from this side. However daily experience proves to be different and this is mainly caused by the fact that we have a lot of national data networks in Europe, which all have to be interconnected and the lack of an "overall" control center. European PTT's are in a very fortunate monopolistic positon : they all have their own small territory and they can permit themselves to be rather "conservative". Some already have claimed not to invest anymore money in the packet switched networks (nor for upgrading, nor for extension).

Finally, we are back to the user. As the end-user is still not using online service on a daily basis, but rather prefers to rely on an "intermediary" we could say that these information services and the proliferation of databases have created a new professional role to be played by the librarian or information officer. The intermediary is an integral part of an interactive system between the user, the computer (using the search language) and the databases. He/she is responsible for a search that is cost-effective and satisfies the user's need. This means that for his information seeking the user relies on somebody else. The intermediary although recognised to be usefull is also considered as being a barrier to the more rapid expansion of the online business, and hosts are looking into ways to give the user direct access to the relevant databases.

From the previous description one can see that there is a mismatch between the sophistication, rigid and unforgiving systems and the relative ignorance of many users. As difficulties one could mention in this connection two :

        a. the existing systems are easy to use only after large investments of time
           and effort needed to learn the the intracacies of the various components;
        b. the existing automatic systems tend to be insufficiently discriminating
           and may inundate the users with unwanted information, or with information
           at the wrong time.

There are two ways to improve the performance of retrieval systems :

        - to change the content of the information records and or the method of search;
        - to introduce an automated interface between the enquirer and the system,
          so as to improve the quality of human-system interaction.

Changing the content of information records will be quite difficult as long as the printed publications constitute the main source of income for the database producers. Once the income from online services will predominate there might be a chance that the producers will be willing to do some redisigning of their database to be better adapted for online searching. However it will be extremely difficult, if not impossible, to convince these database producers to evaluate the information content of the articles and to eliminate those articles which seem to be duplicates. I even could cite a data base, which is no doubt a very good one, but which is sometimes frustrating to the user by outputting sometimes four or five information records from one single article and so he has to pay four or five times royalties.

To get away from these selection and indexing problems one could suggest to have full-text data bases. From the user point of view I would like to express some concerns :
        - set up of those data bases;
        - actual search software badly will need upgrading.

Introducing new techniques in searching as e.g. the use of weighting,clustering ..., certainly improves system performance . It must be possible to make them work through an interface, if one wants them to be used by most users.

The major improvements the users may expect in the near future will be at the interface level. This interface, in an ideal situation,should be able to perform the same functions as the intermediary :

- able to discuss with the user in natural language;
- capable of translating a question into a query
  (knowledge of database content, indexing practices ...);
- to execute the search with an eventual inspection of results
  and modification of the question.

Although a lot of research effort has been dedicated to intelligent interfaces being able to communicate with a human, then is still a lot of work to be done before a competent and human-like intermediary interface will be operational. The current systems, to my knowledge, usually respond accurately only to simple requests and even then they cannot reply reasonably to the user's input without conforming to a rigid grammar. The problem of initiating clarifying sub-dialogues will have to be tackled too.

Hayes and Reddy (5) have enumerated a list of abilities such system should be able to perform. A. Vickery (6) added to this list some more points, most of them being concerned with the user :

- The learning mechanism - the ability of the system to acquire facts, new skills
  and more abstract concepts from experience and the ability to learn from its own
  mistakes. This ability is one of the areas being currently investigated by artifi-
  cial intelligence, for example, AM - a computer program which develops new mathema-
  tical concepts. AM is guided in this exploration by a collection of approximately
  250 heuristic rules.
- Knowledge of the user - the system should have the ability to diagnose the level of
  the user and create his model.
- Correction of errors - the users have to be provided with an opportunity to correct
  their errors (eg. in input) or the system needs to be able to judge the validity of
  the input.
- User friendliness - the system should be user-friendly and easy to use.
- Tutorial aids for users - the system should be equipped with tutorial modules.
- Response time - the response time of the system should be adequate and the variance
  in response time should be minimised.

In Europe with a lot of different languages, implementing systems capable of interacting in natural language with the users will be a tremendous task, but at least something in this direction will have to be done if one wants to reach all possible users.

To the"knowledge of the user"I also would like to add his working environment because this often can help to direct the interaction with the user and in the eventual adaption of the question during the search.

The translation of a question into a query in a well-defined area and for a well-defined group of users may well become available in the near future but the generalization of these techniques to a large area and to a large variety of users will need a lot more research and development work to be done; just as for the inspection of results and modification of the question.

As the user still will have to wait some years to see these idealised systems to evolve, one can expect some simpler systems to be installed shortly. It already would be of a very great help to the user if he could get rid of the "technicalities" (logon, command language ...). Easynet in the U.S. seems to go a long way in this direction permitting end-users to perform at least part of their searches, leaving more time to the experienced searchers in the libraries or information divisions to concentrate on more complex questions.

The Bistel system which has been developed for the Belgian administration has also some very interesting features build in. Through one terminal a Bistel user can receive news from different news agencies as Belga, AFP, Reuter ..., can use a Mailbox system, send his own telexes, search databases from different departments and have also access to IP Sharp and the Celex data base on Euris without having to know the search language.

The European Community is also supporting activities aimed at improving the interface between users and information systems. Following the funding of a study on the possible development of an "Intelligent Interface Facility", which has examined the possibilities for the creation of such a facility but had to conclude that no one solution is feasible for all of the practical problems faced by potential users of information services, the Commission of the European Communities has published an Invitation for declarations of interest for the development of interfaces in its Official Journal, of April 24 this year.

I also should mention the ongoing Docdel experiments, also supported by the Commission, which will help to close the time-lag between the ordering of an original document, be it by normal means or by electronic ordering, and the actual reception of it. If these experiments can be turned into actual operation, then another user concern will have been taken care of. Users then could do a data base search, select some of the most promising titles and transfer these to an electronic store of documents and get immediate copies.

Users may expect to see some of their problems solved in the coming one or two years. However, the success of these developments will mostly depend from the quality of the data transmission networks and the attitude of the national PTT's and from the user willingness to pay for the improved services. Most users are very sensitive to costs and designers should consider this very seriously.

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NEW TECHNOLOGIES FOR IMPROVED INFORMATION SYSTEMS AND SERVICES

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Information data bases are growing exponentially both because of the number of records and because of the type of data. The number of occurences encompassed by a data base has an evident influence on its volume, but as one moves from coded data to textual data and to images the need for space grows as well (Figure 1).

Data is dear to the user. It is expensive to capture and it is important that it reaches all applications which needs it. So to keep the whole problem of data management under control storage, processing and transfer techniques evolve rapidly. This paper is focused on three important technological breakthroughs in each of these domains :

- a new storage technique, the optical disc

- a new way to process data, the expert systems

- a new way to exchange data, with query languages.

Type of Data	Record	Text	Image
Typical Document Size	200 Bytes	2 000 Bytes	20 000 Bytes

Number of documents		Record	Text	Image
	10 000	.002	.02	.2
	100 000	.02	.2	2.
	1 000 000	.2	2.	20.

Figure 1 : Size of data base in Giga bytes

vs. the type of data and number of documents.

1 - OPTICAL DISCS

This part deals with numerical optical disc for professional use (Ref 1, 2) which should represent a market of 100 to 200 thousand units in 1985 and up to 8 million units in 1990

Three important aspects of the optical disc are considered here

- auditability

- low cost per byte

- it requires a specific access method

1.1. Auditability

The optical disc offers a solution to one of the intrinsic flaws of other computer memories.
Each optical cell can be used only once to write data. It can be read any number of times but cannot be further modified. Any attempt to write over existing data may destroy it, but would not result in any readable meaningful data. Like in accounting books, it is not allowed to modify any data. To insert an update some information must be written further in the file to tell what the value should be. This way, unlike with magnetic discs, all update actions can be traced, checked, audited.

With magnetic discs auditability is provided through complex procedures which always rely on trusting some people to apply them. The optical disc brings auditability as a built-in feature which will have an important value for many groups of users.

1.2 Cost comparaison

The technique of update through the storage of a new value requires a lot of space so that the cost of optical and magnetic discs should not be compared byte for byte, but the amount of update should be taken into account.

Let V be the size in bytes of a magnetic data base, and Mg the cost per byte of a magnetic disc. The price to buy the storage for this data base is

$$V. Mg$$

The initial volume of the optical data base is also V.
Let x be the update rate, measured as a percentage of V per unit
of time. At any time t the volume of the optical data base will
be V (1 + xt), and it may grow for ever.

In fact, for any application there are some criteria to keep in-
formation on line or to dismount it. Minimal criteria should be to
keep on line at least one most records are updated, the initial
values are in an area which could be dismounted without harm (Only
those records that have not been, updated should be copied to keep
them on line). Let's call window this set of active records which
must remain on line, W it's size and let T be the time to fill the
window. Figure 2 shows how a window moves over an optical disc
space. A window may be implemented through the use of an index as
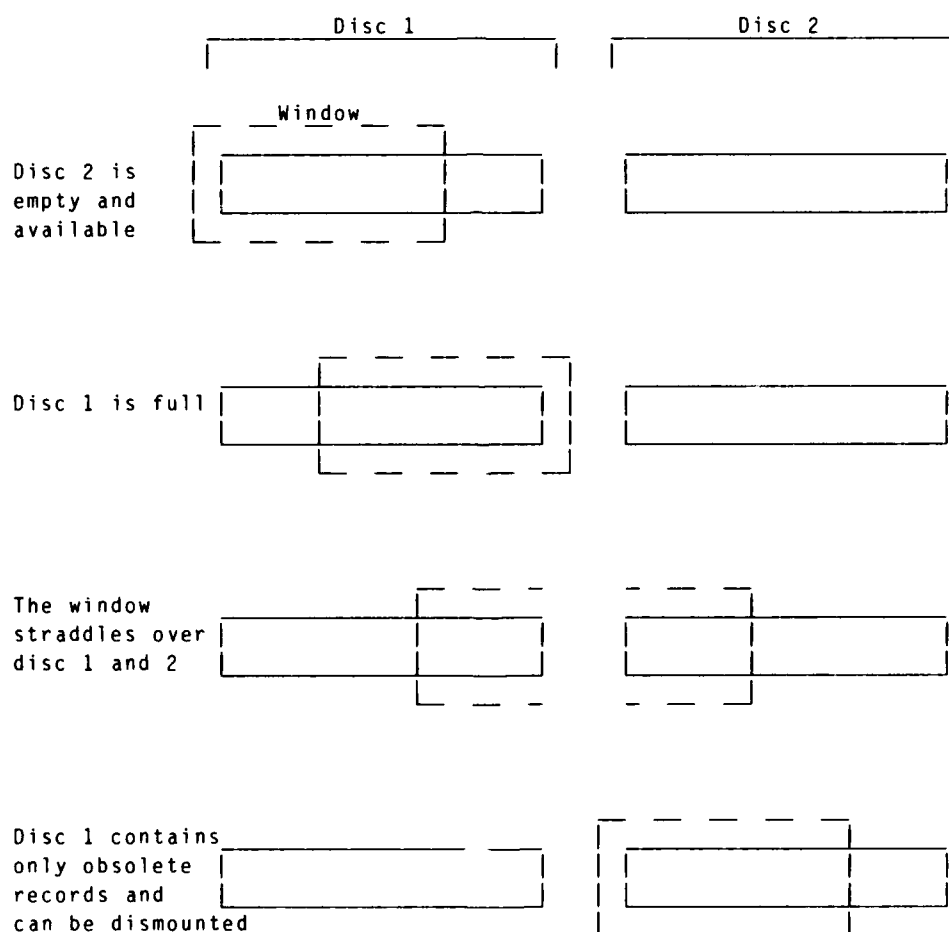explained hereunder in paragraph 1.4.

Figure 2   The window.
The window contains active records,
obsolete records are on its left,
empty space is on its right.

So for a given application for which x and T have some value, the size in bytes of the optical data base will be W = V (1 + xT). The cost per byte of the optical disc being Op, the price to buy the storage for this data base will be

$$W. \ Op$$
or $$V. \ Op. \ (1 + xT)$$

The application will favor the optical disc if

$$V.Op. \ (1 + xT) \quad < \quad V.Mg$$

or $$xT \quad < \quad (Mg/Op) - 1$$

Depending on the size of the discs, it appears that the price ratio Mg/Op could be as high as 10 for small discs, but could also fall down to 2 for large systems.

The table in figure 3 gives the upperbound of the values of T which favor the optical disc for various values of x and Mg/Op.

This table should be read as follows : If the price ratio per byte Mg/Op is 5 and if the rate of update is 3 % per day (or month, or other unit of time) then the optical disc is favored if the window does not require to keep records on line more than 130 days (or month, or other unit).

x % per day		1	3	10	30
Mg/Op	10	900	300	90	30
	8	700	230	70	23
	5	400	130	40	13
	2	100	33	10	3

Figure 3 Upper bound of T in days.
If T is less than the given figure the optical disc is
favored compared to the magnetic disc.

1.3. Data organization

Data organization on an optical disc will be somehow different
from a magnetic disc, as nothing can be updated. This, of course
is true for user data, but it is also true for system data and
pointers which may be required by the access method.

Figure 4 shows how the optical disc can be allocated by means of
chained allocation units. Each allocation unit will contain adja-
cent blocks which constitute the unit of input/output access.
Each block contains adjacent documents. Knowing the address of the
file start, this organisation allows to retrieve or extend the
file.

Figure 4 also shows the possible structure for a document. It
contains four fields :

- The data field. Contains the information
- The key field. Contains the record identifier
- The chain field. It is NULL for an initial value and contains a
  pointer to the previous value of the same document if it is an
  update.
- The control field. It tells the meaning of the document.

        U if a value was stored, either initial or update.

        D for a delete. The record having this identifier should be
          considered deleted.

        C for a copy. The record has merely been copied to stay in
          the window, if for some reason it was not be lost when
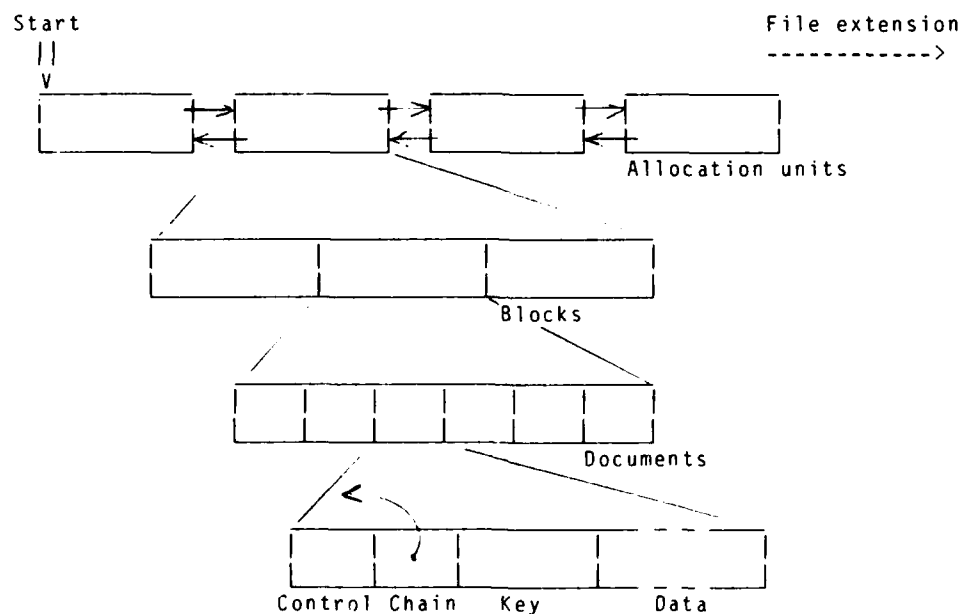   the window was moved.

Figure 4   Data organization

1.4 <u>Data access</u>

As is, the file can be used for a sequential access, either for-
ward or backwards.

For an access through a key, an index is required. Index management
implies a lot of update in the system tables, so that the index
will reside on a magnetic disc. It may be desirable though to read
the data using only the optical disc structure.

Filters are exactly suited for this kind of access.
Filters are intelligent controllers which accept input/output
requests which look exactly like simple queries to relational data
bases and which deliver records like a set of tuples from a rela-
tional data base.(Ref 3,4,5).

When some data is to be retrieved, a request defines the desired
records through conditions on the stored values. The filter reads
the file at full speed, and on the fly, selects the desired records.
The search starts from the end of the file to retain only the la-
test value of each record.

This process can be applied on the optical file itself but is
slowed by the volume of data which has to flow through the filter.

To go faster, an index that is an image of the file containing
only the key fields (the identifier and the fields used for selec -
tion) and a pointer to the actual record, may be built. This index
should be about 100 to 1000 times smaller than the actual file
and will be explored by the filter 100 to 1000 times faster. This
is a way to evaluate the search time :

    If A is the optical disc I/O time (50 ms)
       F is the number of records in the file (20 000)
       K is the index entry size (8 bytes)
       C is the channel throughput (.5 mbytes/s)

The mean direct access time to a record with a given key, would be:

$$2A + (F.K / 2.C) = 260 ms.$$

To maintain a good performance the index should be regularly
rebuilt and cleared of obsolete references. The index is, in fact,
a practical way to represent the window : active records are pointed
by the index, and obsolete records are out of reach. To move the
window one may rebuild the index leaving out the records that are
to be obsoleted.

1.5 View

The above data access method using a filter, is a way to retrieve
any set of records corresponding to a search criteria. It offers,
in fact, a view of the optical file defined by the calling request.
The organization offers two additional facilities to define
specific views :

-A dynamic view which, by following the chain of the successive
values of a given record, allows to retrieve the successive status
of a record over a period of time.

-A historical view. The index, like the main file, grows with
time. By starting the search from any given point rather than from
the end, one will get the view of the file as it was when the end
was at that point. This view, called historical may be used when-
ever one wants to ignore the latest part of the database activity.

2 - EXPERT SYSTEMS

Artificial intelligence has created a new way to express applications.
Without getting into knowledge base systems, let us examine how expert
systems may improve information systems and how a data base may feed
an expert system with information. The examples use a PROLOG Syntax,
and are taken from genealogy.(Ref 6,7).

An expert system is a tool which, when triggered by some request may
deduct the consequences of some hypothesis.

Let's first examine how hypotheses may be stated.

Let say that Marion is an 18 years old person who goes to university.
This may be translated by a clause.

        Person (Marion, 18, university) -> ;
which reads

        "Person Marion 18 university" is true;
or better

        "Marion is a person 18 university" is true;
where the meaning of each value depends on its position.

Other basic hypotheses may be

        Person (Veronica, 17, university)-> ;
        Person (David, 16, school) -> ;
        Person (Elise, 12, school) -> ;
        Person (Martin, 12, school) -> ;
        ...

To tell that Michèle is a parent of Marion, David and Elise, and Jean is a parent of Michèle, one should write :

```
        Parent (Michèle, Marion) -> ;
        Parent (Michèle, David)  -> ;
        Parent (Michèle, Elise)  -> ;
        Parent (Jean, Michèle)   -> ;
```

With such initial data an expert system is capable of deducing it's consequences by the definition of some deduction rules. For instance a grand-parent is a parent of a parent or :

```
        Grand-parent (x, y) -> parent (x, z) parent (z, y);
```
which reads
```
        "x is grand-parent of y" if x is parent of z
                                 and z is parent of y
```

This allows to deduce all the grand-parent relationships from the parent clauses which have been stated. That is from an information base of parent/children, the expert system deduces grand-parent/ grand-child relationships.

The deduction rule may be extended to recursively build an ancestor relationship :

```
        ancestor (x, y) ->  parent (x y) ;
        ancestor (x, y) ->  parent (x z) ancestor (z, y);
```

Which reads

```
        "x is ancestor of y" is true  if x is parent of y
                                      or x is parent of z
                                      and z is ancestor of y
```
With the base of person and parent clauses, and the ancestor and grand-parent deduction rules, the expert system may answer various questions.

Describe the grand-children of Jean ?
```
        grand-parent (Jean, x) person (x, y, z) ;
```

x	y	z
Marion	18	University
David	16	School
Elise	12	School

Who are the ancestors of Elise ?
```
        ancestors (x, Elise) ;
```

x
Michèle
Jean

These questions are the trigger for the deduction process.

The deduction rules stated here are most simple and only show the deduction process. It is like in a domino game, when from a given figure, a chain of dominoes may be built which leads to new figures. Here from a set of hypotheses the expert system builds a chain of clauses to deduce new results. The expert system manipulates the clauses in all possible ways, like a player who tries to combine dominoes in all possible ways to build a chain. To add a clause is like to invent a new domino. One can understand how the invention of a new domino may modify the figures to which the chain of dominoes leads. Likewise, the invention of a new deduction clause leads the expert system to new results.

This power of expert systems may be used to state selection processes, user profiles, deduction rules, which may greatly enhauce the power of information systems.

3 - DATA EXCHANGE

It is obviously tedious to build the initial hypotheses of an expert system, specially when all this information is already available in a base : it appears that the difference between the above clauses and a relation from a relational data base is only syntactical. The first clauses may be written relationally :

Person		
Marion	18	University
Véronica	17	University
David	16	School
Elise	12	School
Martin	12	School

Parent	
Michèle	Marion
Michèle	David
Michèle	Elise
Jean	Michèle

So the hypotheses needed to initialize an expert system may be
output from an information base in answer to a request defining
the desired context, and a syntactial transformation would make
them ready for an expert system.

Let's examine how information servers represented here by the optical
disk filter system and user applications represented here by the
expert systems can be progressively linked and integrated in a
solution and distributed through a network.(Ref 8).

The first paragraph dealt with a storage media which, using a filter,
provided a high level interface. This high level interface would be
analog for any other data base system providing a flow of records in
answer to a query. The second paragraph dealt with expert systems requi-
ring to work on hypotheses which may be stated through the same high
level interface.

Murphy's law states that there is no reason for the two high level
interfaces to be identical and some effort is required to bring them
near each other. A three step evolution is described here.

The minimal level to allow an exchange between information systems
and applications is a file transfer. The data is transfered, hypotheses
or results flow from one to the other as a file. To achieve this, the
user must extract the proper data from one system with its own syntax,
and must tell the other system the description of this data.
At this level, the file transfer requires an off-line data description.

Some progress can be made by letting the two systems exchange automa-
tically the data descriptions. This means that a data dictionary is
attached to the filter or data base system, and the description of
extracted records is sent to the expert system, before transfering the
data.

A third level interface may be defined.
Once both sides use the same description for the fransfered data it
becomes possible to express specific requests, to select more precisely
the needed data. The expert system becomes capable of sending for the
hypotheses it needs, to work out its deductions.

When this third level is reached, the data base, or the optical disc
with its filter becomes an automatic information server. It provides
its data to expert systems that specialize in specific areas to serve
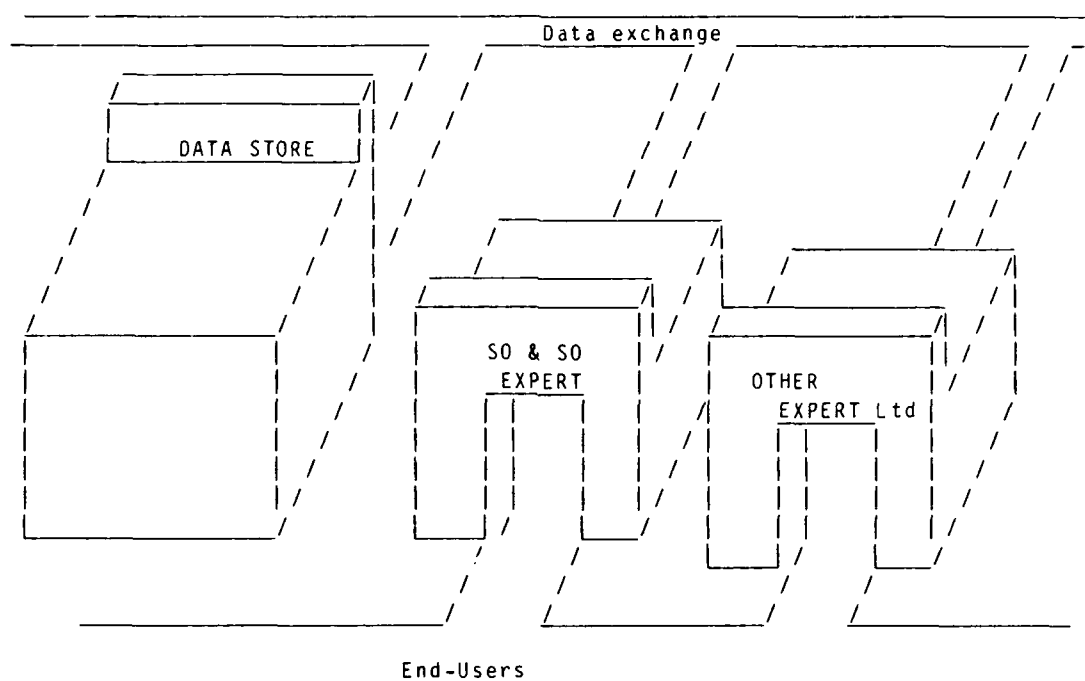end-user needs (Figure 5).

Figure 5 Computer town

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INFORMATION RESOURCES MANAGEMENT IN THE R&D ENVIRONMENT

by

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SUMMARY

Efficient management of highly specialised information is a
permanent task of optimisation, whereby framework conditions
may constantly change on account of various influencing
factors. Owing to their special significance, the following
has to be considered in particular: User needs, available
resources, and information techniques. The task of optimi-
sation, due to its complexity, cannot be solved 'model'-like,
but only approximatively and pragmatically. Illustrated by
the example of the Federal Republic of Germany and the
Fachinformationszentrum Energie Physik Mathematik (FIZ) the
attempt to find a practical solution is demonstrated. In
this context it is shown which role a National Information
Centre plays within international and national cooperation
including worksharing, and how information supply and
dissemination of information works in the case of central
information services by FIZ, and decentral dissemination
of information in research centers. Illustrated by the
examples of database production, online services of
bibliographic, numeric and full-text databases and the
concept of the International Information Network for
Science and Technology (STN International), the importance
of the use of the most modern information techniques is
demonstrated.

1. INTRODUCTION

Wherever research and development is carried out, there is also specialised information
- and there this information is needed again as 'raw material'. In the course of the
history of science and technology a cycle of specialised communication established
itself. In the course of time this cycle became more and more 'work-sharing' - like
other fields of our scientific-technical civilisation. During Gottfried Wilhelm Leib-
nitz' lifetime (1646 - 1716) the world's knowledge was still within grasp and scholars
communicated directly with each other. Libraries and a few scientific publishers (often
scientifically engaged themselves) helped the scientists to collect and disseminate
knowledge.

However, even during the last century individual scientists and scientific publishers
were no longer in a position to document all knowledge. This work was done more and
more by one or the other university institute, scientific library or specialised
documentation centre. The reason for this was the speedy development of natural and
engineering sciences, which produced a flood of scientific findings and data all over
the world. By now, this flood has reached gigantic dimensions. The annual growth rate
for all fields of science can be roughly estimated at:

- more than 2 million articles in journals and books,
- in addition another 1.5 to 2 million publications in the form of research reports,
  patents, technical rules, conference papers, etc, so-called 'grey literature'.

If you add these together you come to some 10,000 publications per day.
Increased research efforts, in particular of the industrialised countries, result in an
annual increase of this flood of publications by some 3 to 7 percent.

This means that the individual scientist or engineer is almost helpless as far as his
own information needs are concerned. Not seldom he has the task of 'finding a needle in
a haystack'. In the basic natural sciences the research scientist in particular is
dependent on scanning, finding, reading and evalutaing relevant literature. Individuals
run the risk of behaving ignorantly, of moving in a 'closed shop' or informing them-
selves 'by chance'. Double work or double and multiple financing are the consequence.
The following example is to illustrate this. The German Patent Office receives some
50,000 patent applications each year. Of these, approximately 20,000, i.e. on average
40%, are rejected because they do not fulfil the criterion 'novelty' upon examination.
This means, either they violate existing protection rights or they do not correspond to
existing knowledge. Starting from overall costs of some 100,000 Deutschmarks for a
single patent development, one arrives at a sum of 2 million Deutschmarks for 20,000
rejected patent applications. /1/ If there had been in good time systematic patent and
literature searches, these costs could have been avoided or considerably reduced.
Besides avoiding work or development repetition of this kind, the utilisation of modern

information systems can contribute to rationalise research work by saving the scientist lengthy searching. For instance, we have found in a planning study carried out by us that scientist who work in research and development (in the fields of mathematics, physics and the subjects of aeronautics, astronautics, space research, nuclear research and technology) on average need 20% of their working hours for information (searching, acquiring, reading, evaluating); for the searching process alone an average of 5% of the working hours. Efficient information systems which make use of sophisticated high-quality databases and modern information technologies can reduce this manpower considerably. Here another example to illustrate this: A physicist of the Nuclear Research Center Karlsruhe had an online search made in our databases on his research subject 'Dipole distributions on plain surfaces'. There were few items which were really pertinent, however, one of them contained exactly the information he was looking for. This meant that a literature search with a small percentage of pertinent publications was nevertheless a full success. 'It would have been very difficult for us to have got at just this information some other way. It means for us a saving of half a to a full year of manpower.' /2/ With reference to the costs prevailing in the Research Center named above this means:

- Price for the database search 220,- Deutschmarks
- Savings in manpower 50,000 Deutschmarks.

Even if this is a rather extrme example, the question arises: How can information resources be managed in order to reach approximative cost-befenit relations in the field of research and development.

2. INFORMATION RESOURCES MANAGEMENT IN THE R&D ENVIRONMENT ILLUSTRATED BY THE EXAMPLE OF FACHINFORMATIONSZENTRUM ENERGIE PHYSIK MATHEMATIK GMBH IN THE FEDERAL REPUBLIC OF GERMANY

Efficient management of highly specialised information is a constant task of optimisation, whereby the framework conditions may change on account of several influencing factors. The main conditions are:

- the need for specialised information by scientists and engineers in research and development
- available information technology
- available financial resources

These framework conditions are not static, they are subject to changing outer influencing factors and they influence each other interactively. The main influencing factors are research-political targets, technical developments and aspects of information, finance, industry, and legislation. On account of this complexity, optimisation of an information system therefore cannot be solved theoretically, but only approximatively and pragmatically.

In the following it is illustrated by the example of Fachinformationszentrum Energie Physik Mathematik, Karlsruhe, how in the Federal Republic of Germany the fields of energy, nuclear research and technology, aeronautics, astronautics, space research, physics and astronomy, mathematics and informatics are covered in information and documentation in order to meet the information requirements of research and development as efficiently as possible. /4/

2.1 Providing and disseminating information

In addition to a number of other specialised information centers, FIZ KA works in the fields mentioned and supplies as a supraregional information centre individual information on specialised literature, data and facts by offering the following information services:

- Online service
- searches and SDI
- scientific/technical information and referral ervices
- bibliographies on topical subjects (series or single issues)
- magnetic tape services
- printed information services in periodical or irregular intervals
- consultancy services for intermediaries and information offices

The dissemination of information is shifted more and more to the Online Service and the Magnetic Tape Services, which results in a tendency towards:

- central collection, compilation and availability and
- decentralised dissemination and support for end users.

In this context FIZ cooperates with public and internal intermediaries, e.g. in Chambers of Commerce, industrial firms, universities and in research centres. As a rule, research centres which work in the fields mentioned above get a flat-rate service agreement which enable their scientists to have online access to centrally available databases in an unbureaucratic way. A pertinent example here is the cooperation with

the Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt (DFVLR). DFVLR
has some 3,000 employees in research centers in Brunswick, Göttingen, Cologne, Ober-
pfaffenhofen and Stuttgart, about 1,000 of these are scientists and engineers. Each of
these centers has not only its own library but also an information intermediary servi-
ce. As well-trained information officer has a terminal with printer which is connected
to the databases available at FIZ in Karlsruhe. The scientist looking for information
searches together with the information officer. The FIZ Online Service disposes at
present of 68 databases in science and technology: 42 are of a bibliographic nature,
15 numeric and factual databases, and 13 other (referral and training databases). With
bibliographic databases I mean references databases with bibliographic data, abstracts,
descriptors, etc. Numeric and factual databases contain primary information in the
form of figures, statistics, physical and chemical materials data or graphical infor-
mation in the form of spectra, chemical structure formulae, etc. At present the online
user has with three retrieval systems (GRIPS/DIRS, GOLEM, ADABAS), all in all, 13.6
million items in a 50 gigabyte storage at his disposal.

Bibliographic reference databases on the one hand and numeric and factual databases on
the other hand have still to be stored at present, on account of some major structural
and contents-related differences, in different retrieval systems. Latest developments,
however, will lead to a uniformity of retrieval systems (see chapter 3). Databases are
licensed, offered by third parties, or produced by FIZ itself.

2.2 Database Production

FIZ produces 20 databases, some on its own, some in cooperation with national and
international partners (11 bibliographic, 5 numeric and factual, 4 referral), in the
context of which the national and international cooperation is of particular impor-
tance for reasons of completeness, timeliness and favourable costs as well as longterm
assurance of information supply on account of unlimited availability rights on these
databases. In the fields of energy, nuclear research and technology as well as aero-
nautics and astronautics, space research, there have been international agreements on
work-sharing cooperation for many years. As an example I will take the Energy Informa-
tion Database which is produced under the leadership of the U.S. Department of Energy
in cooperation with Denmark, France, Finland, Federal Republic of Germany, Great
Britain, Netherlands, Norway and Sweden. Every member state covers the energy-relevant
documents published in its territories and supplies the items, processed according to
appropriate rules, every fortnight to OSTI. There a cumulated tape is made, which is
distributed just as regularly to the partners for their disposal. The proportion of
the Federal Republic of the overall input is 18,000 records per year, which is roughly
12%; the proportion of the costs is of course accordingly. As this is worldwide the
most comprehensive and most important energy database, which is not available on other
terms, the cooperation partners save considerable input costs. Input cooperation
agreements of this kind exist for another 10 databases.

Another possibility of rationalising input is seen in close cooperation with publishers.
Efficient publishers of scientific journals can supply nowadays machine-readable
bibliographic data and abstracts of journal articles on tape in the course of their
photocomposition work. This saves multiple typing, proof-reading, etc. and reduces
input costs. This development is only at the beginning, because so many publishers and
printers are involved when producing an extensive bibliographic database. Further
developments, up to electronic publishing, awake expectations of more rationalisation
possibilities in the future (see chapter 3).

3. NEW INFORMATION TECHNOLOGIES

Part of successful information resources management is the continuous observation of
developments and trends in new information technologies. FIZ sees in this the possibili-
ty to improve existing services and to develop new user-friendly services, like for
instance full-text databases including graphics, electronic document delivery; in
addition this means possibilities for more rationalisation and an improved relation
cost/benefit. Here follow the three most important projects in which FIZ is involved
at present.

3.1 Electronic Publishing and Electronic Document Delivery

FIZ participates in cooperation with four scientific-technical publishers and the
Gesellschaft für Information und Dokumentation, Frankfurt, in the project Electronic
publishing of scientific-technical texts, a project promoted by the Federal Ministry
for Research and Technology and the CEC in 1984/85. The project aims at developing an
integrated electronic system for editing, storage in a device-independent format,
processing and delivery of technical-scientific publications and at testing a broad
spectrum of applications.
FIZ is involved in the overall concept, in developments concerning aspects of publishing
and terminal-equipment, and has in particular tasks concerning databank production,
host adaptation, and host operation. An integrated databank system with bibliographic
reference databank, full-text databank and facsimile storage is built on the basis of
the systems ADABAS, NATURAL, DINAR and special further developments.

3.2 German Patent Information System

FIZ plays a leading role in the pilot project for the development and set-up of a German Patent Information System in 1984/85, a pilot project which is again promoted by the Federal Ministry for Research and Technology and the CEC. Consortium partners are the Federal Ministry of Justice/German Patent Office, Satz-Rechen-Zentrum Hartmann und Heenemann and the Gesellschaft für Information und Dokumentation. The pilot project aims at
- developing and setting up a national German patent databank with text and graphical information and
- making this information available to the interested public in the form of various computer-aided information services, in particular through online access via public telecommunication networks, combined with the possibility of cross-file searching in scientific-technical literature and factual databanks and other patent databanks.

The emphasis of the technical developments is put on the combined storage of text and graphics in one databank, digitalisation and conversion of graphical information in vectorgraphic storage and output format as well as the combined transmission of text and graphics via public telecommunication networks on available types of suitable end equipment.

3.3 STN International, the International Information Network for Science and Technology

The American Chemical Society and FIZ Karlsruhe have linked their online computer information services in an international scientific and technical information network. An agreement concluded by the two organisations has connected the Chemical Abstracts Service computers in Columbus, Ohio, and the FIZ computers in Karlsruhe through a dedicated telecommunication link in three phases from 1984 to 1987. The two computer systems will use the same software so that the same command language can be used for searching information files at both locations.
A result of the networking link is to make Chemical Abstracts Service's CAS ONLINE substance search service, which has been offered exclusively from Columbus, accessible to European users through the Karlsruhe node of the network and FIZ Karlsruhe's exclusive files accessible to North American users through Columbus. Both organizations produce offline prints of search results locally in order to speed up delivery and both operate help desks to provide local assistance to network users. Under the network arrangement, a particular database will be loaded at only one site, eliminating duplication in file storage and updating costs. A searcher will access the nearest host computer and be switched automatically to whichever computer in the network stores the database to be searched. The searcher will perceive the network as a single comprehensive system and will be able to search any number of files in one session without being aware that some of the files may be physically located on another continent.

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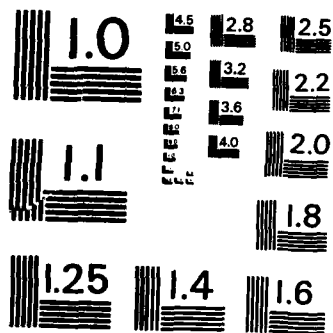|	
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14. Abstract

The Technical Information Panel of AGARD is concerned with the storage, retrieval and dissemination of scientific and technical information relating to aerospace and defence.

The Specialists' Meeting organised by the Panel in 1985 was concerned with the value of information as an integral part of aerospace and defence R & D progr mmes. Ten papers were presented, comprising the following topics: the information required at three different levels — policy-making (two papers), programme management and research; the quantitative value of information (two papers); the need for international exchange of information; information resources management; the requirements for the future; and the likely impact of new technologies.

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